THE

ELECTRICAL REVIEW.

VOL. LI. DECEMBER 5, 1902. No. 1,306.

"ELECTRICAL REVIEW."

Vol. LI.] CONTENTS: December 5, 1902. [No. 1,306.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1902 Edition

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DEPRECIATION AS IT AFFECTS ELECTRICITY WORKS AND MACHINERY.

IN our observations upon an article in *Cassier's Magazine* upon electrical industries in the United States (ELECTRICAL REVIEW, November 21st, 1902, page 882) we referred to the fact that in America depreciation frequently amounts to 100 per cent. of the cost in a single year.

The cause of this is no doubt due to the practice of some engineers to select their plant not so much with a view to a long life, as from the knowledge that in the present developing condition of the science of electricity supply, the question of *antiquation* is of more consequence than durability.

In the paper by Mr. Charles H. W. Biggs, read at the Society of Engineers on the 1st inst., the connection of the engineer with the question of depreciation formed the subject of the opening paragraph, and the author dealt with it only on the consideration of *durability*, omitting any reference to the theory of *antiquation*, which involves, perhaps, the most important element in the calculation.

In the construction of electricity supply works engineers have not always had a free hand in selecting the plant, and this was especially the case in the early days of the industry, when the owners of patents of dynamo machines, engines, &c., practically controlled what should be employed. This system has frequently resulted in heavy loss, through the necessity of scrapping expensive plant, when it proved to be antiquated or unsuitable for the purpose for which it was installed.

The practice of some engineers in selecting their plant with a view to economy of expenditure in order to meet the views of their clients, is, no doubt, an extravagant policy in the long run, and Mr. Biggs is right in denouncing those who "work for the present, and not for the future."

The main object in designing an electricity supply undertaking should be to combine thorough *efficiency*, in the fullest sense of the word, with economy—having a due regard to the progressive character of the industry.

It has been found in the case of ground landlords who have granted building leases for too short a period, that the speculative builder has acted upon the principle of the gentlemen referred to by Mr. Biggs who "split hairs about the strength of a cobweb," by constructing his houses to last according to the length of his lease, and not with a view to durability. The result may be profitable to the builder who does not trouble himself about futurity, but is very costly to the ultimate possessors of the property.

Mr. Biggs adopts the theory of dividing municipal undertakings into productive and non-productive, but he would probably be nearer the truth if he distinguished them as municipal *enterprise* and municipal *trading*; both are intended to be productive, but, in the one case, the return is

in the shape of improved health and prosperity due to the increased attractiveness of the town, while, on the other, it is purely speculative, especially when providing for the demands of a mere section of the residents, for whose benefit the whole body of ratepayers have no right to be involved in risk.

Mr. Biggs instances sewerage as a non-productive work, and asks whether anyone has ever suggested that, in addition to the upkeep and repayments of loan, a third charge upon the rates for "depreciation" should be made? Certainly not; nor does it bear the slightest analogy to a trading business, such as electricity supply.

The proper drainage of a town is absolutely essential as a sanitary matter, affecting every inhabitant, and the cost is properly divided among the whole population by means of rates levied for the purpose, the return to the ratepayer being in the saving of capital outlay and greater efficiency than was incurred under the primitive system of sewerage carried out by the individual householder.

Upon the general principle of provision for depreciation as a charge upon municipal undertakings, we join issue with Mr. Biggs, and retort that his contention that no such fund is necessary, is economically unsound, and we refer him to the practice of the municipalities he has mentioned, viz., Aberdeen, Bolton and Glasgow, as supporters of our view. In all these cases depreciation is provided for, so far as the exigencies of the trading will admit, *in addition to repayment of capital and upkeep of the plant.*

Mr. Biggs asks: "Is the repayment of capital depreciation? If not, what is it?"

We should have expected Mr. Biggs to know that the sinking fund is only applicable to the payment of the *original cost of the plant*, and cannot be applied either for upkeep or depreciation. How then can the repayment of capital cover wear and tear, depreciation and loss of value by antiquation?

The actual practice is for fresh borrowings to be made for renewal of plant, with the result that at the end of the term when the original capital has been paid off, a fresh capital represented by new loans will exist and no asset remain in connection with the original expenditure.

If the undertaking were to prove to be so profitable that both maintenance and renewal were paid for out of revenue, there would, of course, be a valuable asset when the capital was repaid; but this would be in the nature of a depreciation fund, provided in the most satisfactory manner.

In dealing with companies' accounts, Mr. Biggs considers that if they place to reserve the amount for depreciation, they will gradually accumulate funds equal to the original capital and come to the same point as municipalities under the sinking fund scheme; but this is a fallacy, because, as we have shown, the repayment of the capital by the municipality would only repay original cost, while in the case of the company the reserve fund would provide for depreciation and antiquation.

Mr. Biggs assumes the position of a municipality and that of a company as being the same for the purposes of his argument, but he loses sight of the important and irreconcilable difference between the trading on borrowed capital, subject to 3 or 4 per cent. interest, and the payment of a dividend according to the results of the trading.

We shall not follow Mr. Biggs into his theories of competition, which we cannot reconcile with his own arguments, for he says "in these things competition is absolutely impracticable," and concludes by remarking that "the artificial restriction of competition may, and does, unduly penalise the present user."

Bills and Provisional Orders—Session 1903.

THE preliminary announcements of the promotions in the next session of Parliament indicate the rapid development of the system of supply by long-distance transmission of electrical energy over large areas. It is also significant that much wider powers are being asked for under the present schemes than the mere supply in bulk to authorised undertakers, which constituted the scope of the Acts hitherto obtained. In the interest of the public no restrictions are justifiable which interfere with the supply of electricity for all purposes upon the most economical terms.

Among the Bills announced we may quote from two which embody the extended powers which the promotors desire to obtain. The Carmarthenshire Electric Power Co. ask for powers over an extensive area for the "production, storage, use, transmission, conveyance, measurement, distribution and supply of electric energy or of power, and for providing and working materials for that purpose, or for fitting-up and repairing such articles, matters and things as aforesaid, or to make changes therefor or otherwise carrying on the undertaking of the company." The Shropshire, Worcestershire and East Denbighshire Electric Power Co. ask to be able "to produce, generate, transform, transmit, convey, store and use such energy, power, materials, products, matters and things, and *to supply and distribute* the same to and within" the counties of Salop, Worcester, &c.

In the Metropolitan area the London County Council announce for a second time their proposal to purchase all the electric undertakings within the County of London. The Wood Green Urban District Council revive the North Metropolitan scheme which came to grief two years ago through the successful opposition of the ratepayers, and we may expect a similar result to the present application, which provides for agreements with local authorities for bulk supplies, and "To empower the Council and the Local Authority of any district adjacent to the district of the Council to enter into agreements for the supply of electrical energy in bulk, and to empower the Urban District Councils of Hornsey, Tottenham and Edmonton, to supply energy in bulk to the Council." It is rather a curious procedure for Wood Green to ask Parliament to give powers to Tottenham and Edmonton to supply them, instead of leaving those two authorities to obtain the powers for themselves, and it would not be surprising if the ratepayers in those districts suggested to Wood Green to mind their own business.

In connection with the supply of the North Metropolitan districts—the arrangements already made for the authorised tramways in the Counties of Middlesex and Hertfordshire, have an important bearing. The Local Authority of Wood Green could not supply upon such favourable terms to the consumer, as the company which procures a day load by supplying electrical energy to the tramways, and there appears to be no *raison d'être* for municipal trading under such circumstances.

Several other promotions deal with the extension of areas of supply, by the combination of existing local companies having contiguous districts of supply, or by obtaining powers for laying mains beyond the existing limits of the Provisional Orders. Thus, the Blackheath and Greenwich, Lewisham and Crystal Palace and District Companies, pro-

pose to unite for the supply of the extensive areas extending from Upper Norwood to Blackheath, and if the supply of the South London Tramways can be arranged for, the business should be a good one; but if the London County Council succeed with their Bill for swallowing all the undertakings in their area, the scheme cannot be carried out.

The Cheltenham Corporation want to supply outside their borders, and the Oldham Corporation seek powers to accept transfers of other electric lighting undertakings. The Cleveland and Durham County Electric Power Co., at present limited to the supply of energy in bulk, ask for powers to acquire and work other electric undertakings. The Sutton Coldfield Corporation wish to supply in bulk outside their Borough, and the Leigh Corporation ask for similar powers to supply neighbouring authorities. The Salford Corporation promote a Bill for the transfer of the Provisional Orders for the supply of Swinton and Pendlebury, &c. The Bradford, Stafford, Wimbledon and Bexley Local Authorities, and the Uxbridge and District, Leatherhead and District Companies are all endeavouring to obtain powers for extending their areas of supply. With all this evidence of the general recognition of the principle of comprehensive systems of supply over large areas, it is anomalous to find numerous Local Authorities applying for Provisional Orders for small isolated towns such as Brentwood with a population of 4,932, Scunthorpe with 6,750, Sidmouth, 4,201, Launceston, 4,053, Chard, 4,737, the last named town asking for power to purchase the gas company as well as supply electricity—a poor look-out for those who desire a good and cheap electric light.

Among other provisions in the Bills promoted by local authorities are attempts to postpone the sinking fund, in one case—that of Sheffield—the application being included in a very miscellaneous omnibus Bill, which covers the removal of human remains and the letting on hire of electric motors. The Exeter Corporation would like to have a little more freedom in keeping their accounts, so as to determine as to which undertaking—tramways or electric lighting—"any expense, matter or thing shall be assigned."

The number of applications to be dealt with in the next session is rather more numerous than in the sessions of 1901 and 1902—the total being about 80, of which 50 are promoted by local authorities. The Board of Trade are introducing another Bill for rectification of areas of supply in existing provisional orders.

The Etiquette of "Handles."

The last issue of the *Proceedings* of the Institute of Chemistry of Great Britain and Ireland contains the following paragraph:—"In journals and elsewhere the initials 'F.I.C.' and 'A.I.C.' are occasionally found attached by inadvertence to the names of persons who have no right to them. In such cases no fault attaches to the individuals concerned, who, not infrequently, immediately apologise for the mistake. In other cases of irregular use, the offenders have allowed their membership of the Institute to lapse. Recently, however, the Council have dealt with an individual, never in any way connected with the Institute, who was discovered to be using the initials 'F.I.C.' in certificates of analysis and also on the door of his office. On receiving from the offender an apology for the fraud and a written undertaking to cease using the initials, the Council decided to take no further steps in the matter, but they feel strongly that such offences cannot be dealt with so leniently in the future. They have, therefore, decided to address other institutions whose diplomas are granted after examination, to secure their co-operation in obtaining further protection for titles conferred under the provisions of Royal Charters."

If we are justified in finding any fault with this statement, it can only be that the wording errs on the side of mildness. The state of affairs it illustrates is notorious; but we are cynically doubtful whether the culprits are often so ignorant as the Council represents them to be. When they are not ignorant—and we take it to be the duty of a consultant to see that qualifying initials are not wrongfully affixed to the signature he appends to such reports and certificates as are used for publication—when they are not quite ignorant that this kind of thing is done, they display a degree of moral laxity which is unpleasant to contemplate, and which suggests a possible lack of trustworthiness in still more important directions. Confining ourselves still to chemistry, though similar remarks apply with equal force elsewhere, the general public does not always realise that the letters "F.I.C." imply a qualification, whereas "F.C.S." does not. Still, in various obvious ways, it is as desirable for their own sake that the public shall be taught which is a qualifying "handle," as for the consultant only to use such if he has a right to it. It is dishonourable, almost dishonest, for a man to call himself an "F.C.S." incorrectly; but it is a "fraud" on the public, in the words of the Council of the Institute, for such a one to append the letters "F.I.C." to his name without justification; and the more we succeed in impressing upon the public at large that qualification is advantageous, the greater will that fraud become.

The doctors, the lawyers, and the pharmacists are very particular about their qualifications, guarding them jealously against abuse. They have the law behind them, and their efforts are successful. But in these days it can hardly be maintained that our physicians, solicitors, and druggists occupy a position of appreciably graver responsibility towards their clients than do consulting electricians, engineers, and chemists; the doctor, of course, deals with matters of life and death, and so does the druggist, but other professional men have control of enormous sums of money, while their advice is constantly being sought in the most momentous questions of public hygiene. Not only in order to protect the qualified professional man, but also to protect the public against consultants of lower moral calibre; not only to raise the social position of the professional man and to exalt the trained over the untrained individual, but also to enable the public to distinguish between the man of learning and attainments and the empiric, this common abuse of qualifying initials ought to be put down. And if the law of the country is not capable of doing this when set in action by councils and censors of our learned societies, it ought to be strengthened without delay. We are glad to see that the Institute of Chemistry is again approaching its peers on the subject, and we sincerely hope it will meet with the response it undoubtedly deserves. A representative deputation from all our qualifying societies should certainly be able to gain a hearing from the authorities, and should do much to remove an intolerable disgrace.

Calcium Carbide Patents.

On Wednesday, November 26th last, the Court of Appeal, consisting of Lords Justices Vaughan-Williams, Stirling, and Cozens-Hardy, upheld a decision given by Mr. Justice Buckley on February 3rd, and decided that Willson's British Patent, 16,705, of September 1st, 1894, is bad, on the grounds both of anticipation and want of subject matter. Thus the Acetylene Illuminating Co., who, as owners of Willson's patents, were the plaintiffs in both cases, have lost their cause; and apart from the employment of special types of plant, the manufacture of calcium carbide is free from monopolisation in Great Britain. The whole question of carbide patents in Germany, France, and the United States was discussed in our issue for October 10th last, in an article which explained the claims made in the several specifications concerned. To that article we have nothing to add on the present occasion, beyond expressing a wish that the Acetylene Illuminating Co. may be content with two adverse decisions, and will not keep the industry in further suspense by instituting an almost hopeless appeal to the ultimate Court.

THE USE OF SPECIFICATION FORMS IN DESIGNING DYNAMO MACHINERY, AND THE DESIGN OF A ROTARY CONVERTER.

By H. M. HOBART.

In all manufacturing concerns, the designers employ printed forms for recording the constants of the machines. The series of forms described in this article have been prepared for use in designing continuous-current commutating machinery.* In their preparation a large number of earlier forms have been consulted with a view to making the present set as complete and useful as practicable. It may appear to some that the specification is excessively long, but the writer has found this desirable for reasons which will appear in the course of this article.

Sheet I.

SPECIFICATION FOR COMMUTATING MACHINES.

~~Dynamo~~ ~~Motor~~ Rotary Converter.

Designation of Machine.—*Six-phase, Shunt Wound, Rotary Converter, for a normal output of 100 KW. at 120 volts and 750 r.p.m.*

Date :—1901.

Normal Ratings.	A	B	C	D
Number of poles	8			
Normal rating in kilowatts	100			
Normal rating in horse-power	—			
Speed in revolutions per minute	750			
Periodicity in cycles per second	50			
Terminal voltage—full load	120			
Terminal voltage—no load	120			
Amperes output—full load	833			
Number of collector rings	6			
Voltage between collector rings	74			
Voltage per phase (*i.e.*, from col. rings to neutral point)	42·5			
Amperes per collector ring	435			

Sheet II.

List of Drawings.

Magnet frame	No.	Equaliser rings	No.
Field spools	"	Terminal blocks	"
Armature laminations	"	Base	"
Armature spider	"	Shaft	"
Armature flanges	"	Bearing at commutator end	"
Armature winding	"	Bearing at driving end	"
Commutator	"	Assembly	"
Brush-holder yoke	"		

Constructional Specifications, Test Reports, Connection Diagrams, &c.

Armature winding specification	No.
Field winding specification	"
Test report	"
Connection diagrams	"
Shop order	"

Especial Conditions :—

Guarantee :—50% overload, with unity power factor, during two hours without harmful sparking or heating. Thermometrically measured temperature increase of the warmest accessible part, not over 50° Cent. above surrounding atmosphere during continuous operation at rated load. No harmful sparking or heating with momentary overloads of 100%. Insulation of entire machine from copper circuits to iron, to withstand, at 60° Cent., for one minute, the application of 3400 R.M.S. volts.

Sheet III.

Dimensions (in mm.).	A	B	C	D
Armature: External diameter	676			
Axial length of the winding	330			
External diameter of the laminations	672			
Diameter at the bottom of the slots	610			
Internal diameter of the laminations	451			
Circumference (external)	2115			
Pitch at circumference	252			
Circumference at the bottom of the slots	1950			
Pitch at the bottom of the slots	244			
Insulation between laminations—per cent.	10			
Insulation between laminations—material	*Varnish*			
Thickness of punchings	4			
Depth of the slot	27·5			
Width of the slot at the root—as stamped	12·1			
Width of the slot at the root—assembled	11·6			
Width of the slot at the periphery—as stamped	12·1			
Width of the slot at the periphery—assembled	11·6			
Number of slots	94			
Number of slots per pole	10·5			
Width of tooth at periphery	19·1			
Minimum width of tooth	11·0			
Average width of tooth	12·05			
Radial depth of the laminations	111			
Radial depth of the laminations below slots	99·5			
Number of ventilating ducts	3 + 2*			
Width of the intermediate ducts—each	10			
Width of the end ducts—each	5			
Total axial length occupied by ducts	40			
Total axial length occupied by insulation	7			
Effective length of magnetic iron	74			
Axial length between flanges—total	121			
Effective length of core ÷ total length of core	·61			

* 3 intermediate ducts and 2 end ducts.

Sheet IV.

Dimensions (*continued*).	A	B	C	D
Bar winding: Height of uninsulated conductor	11			
Bar winding: Width of uninsulated conductor	1·7			
Bar winding: Height of insulated conductor	11·7			
Bar winding: Width of insulated conductor	2·4			
Wire winding: Diameter of wire—bare	X			
Wire winding: Diameter of wire—insulated				
Wire winding: Gauge number				
Insulating material on the wire or bar				
Width of commutator connections				
Thickness of the individual strips				
Number of strips per commutator connection				
Width of the collector ring connections				
Thickness of the collector ring connections				
Thickness of the slot insulation—copper to iron	1·35			
Thickness of the main slot insulation				
Thickness of the insulation on each conductor				
Thickness of the insulation around each group of conductors				
Thickness of the insulation between the groups				
Thickness of the top wedge or covering strip				
Number of binding bands on the core	1			
Number of turns per binding band	10			
Diameter of the wire composing the binding band	1·0			
Number of binding bands on the end connections	4			
Number of turns per binding band	16			
Diameter of the wire composing the binding wire	2·0			

Sheet V.

Dimensions (*continued*).	A	B	C	D
Magnet Core: Length of the pole face parallel to the shaft	110			
Pitch at the bore of the pole face	267			
Mean length of the pole arc	170			
Maximum length of the pole arc	170			
Minimum length of the pole arc	170			
Thickness of the pole shoe at the centre of the arc	20			
Radial length of the magnet core	150			
Width of the magnet core parallel to the shaft	190			
Width of the magnet core at right angles to the shaft	681			
Diameter of the bore of the pole face	4			
Radial depth of the air gap (*extra fat*)				
Yoke: External diameter over the ribs	1180			
Internal diameter	1060			
Thickness of yoke—exclusive of ribs	60			
Axial width	260			
Height of the ribs	—			
Width of the ribs	—			
Radial thickness of the pole cast	19·5			

Sheet VI.

Dimensions (*continued*).	A	B	C	D
Field Spool: Length overall	150			
Thickness of the flange insulation	No end flanges			
Thickness of the inner insulation				
Thickness of the flanges				
Length of the shunt winding space	150			
Length of the series winding space	No series			
Depth of the shunt winding space	50			
Depth of the series winding space	No series			
Shunt conductor—gauge number	—			
Shunt conductor—bare diameter	2·5			
Shunt conductor—insulated diameter	2·8			
Thickness of insulation between layers	0·5			
Series copper—width—gauge number	No series			
Series copper—thickness of the conductor—diameter				
Series copper—number of strips in parallel				
Thickness of the insulation between layers				

There are few firms that have not frequently gone through the expensive experience of finding too late that errors existed in the calculations underlying guarantees. This is often the consequence, not only of lack of time for careful estimations in such cases, but of the dearth of any really reliable data of the designs of the machines listed by

* The sheets are all of the same size, perforated for filing; but as here reproduced, the blank spaces left for possible future additions have been omitted. Sheet III. is shown complete; all the sheets are about 8½ × 11 inches.—Eds.

Sheet VII.

Dimensions (continued).	A	B	C	D
Commutator: Diameter	480			
Number of segments	336			
Thickness of a segment at the periphery	3·70			
Thickness of a segment at the inner edge	2·23			
Height of a segment—total	80			
Useful depth of a segment	35			
Total length of a segment	420			
Useful length of a segment	400			
Length from external end to commutator connection	400			
Thickness of the insulation between segments	0·76			
Thickness of the main insulation	1·5			
Brushes: Number of sets	6			
Number per set	10			
Radial length of the brushes	65			
Width of the brushes	32			
Thickness of the brushes	13			
Length of the arc of contact	13·5			
Contact surface per brush (sq. cms.)	4·2			
Material of the brushes	Carbon			
Brush designation	—			

Electrical and Magnetic Data.	A	B	C	D
Armature: Total induced voltage, full load	125			
Terminal voltage, full load	120			
No load voltage	120			
Winding	Bar			
Number of face conductors	672			
Number of slots	84			
Number of conductors per slot	8			
Arrangement of the conductors in the slot	[illegible]			
Parallel elements making up one conductor	1			
Style of winding	Loop			
Total amperes from commutator	835			
Number of circuits	8			
Amperes per circuit as dynamo—as motor	104			
Ratio of resultant to cont. current as rotary conv. (P.F. = 1)	71			
Resultant amperes per circuit as rotary converter (P.F. = 1)	74			
Total number of parallel paths through the winding	8			
Number of conductors in series between brushes	84			
Gramme ring or drum winding	Drum			
Construction—type	Cylindrical end-connections			
Mean length of a single turn (cms.)	92			
Total number of turns	336			
Number of turns in series between brush	42			
Total length of conducting path between brushes	3900			
Cross section of one conductor (sq. cms.)	·187			
Cross section of all parallel conductors	1·50			
Specific resistance at 20° Centigrade	·0000017			

Sheet XI.

Commutator (sparking constants).	A	B	C	D
Number of poles	8			
Number of segments	336			
Number of segments per pole	42			
Voltage	120			
Volts per segment	2·86			
Number of slots	84			
Number of slots per pole	10·5			
Total number of face conductors	672			
Number of conductors per slot	8			
Armature turns per pole	42			
Armature turns per segment	1			
Total current strength	835			
Style of winding (wave or loop)	Loop			
Style of winding (single, double, or triple, &c)	Single			
Number of circuits	8			
Amperes per circuit	104			
Armature ampere-turns per pole	4370			
Diameter of the commutator (metres)	0·48			
Revolutions per second	12·5			
Peripheral speed in metres per second ($= A$)	19			
Normal thickness of the brush	13			
Length of the arc of contact ($= b$) mm.	13·5			
Frequency of commutation (cycles per second) ($= \frac{\text{Volts} \times A}{\text{Amperes}} = n$)	700			
Width of a segment at the periphery (including insulation)	4·46			
Maximum number of turns short circuited under a brush	3			
Turns per spool (q)	1			
Max'm No. of simultaneously commutated conds. per group (r)	6			
Mean length of one turn (cms.)	92			
Effective length of core (cms.)	7·4			
"Free length" per turn (s)	77			
"Embedded length" per turn (l)	15			
Lines per ampere-turn per cm. of "free length" (w)	·8			
Lines per ampere-turn per cm. of "embedded length" (y)	4			
Lines per ampere-turn for "free length" ($w \times s$)	62			
Lines per ampere-turn for "embedded length" ($y \times l$)	60			
Lines per ampere for "free length" ($z \times w \times s$) $= \sigma$	186			
Lines per ampere for "embedded length" ($r \times y \times l$) $= p$	360			
Total lines linked with short-circuited turn per ampere ($\sigma + p$)	546			
Inductance per segment—henrys—$\frac{q \times (\sigma + p)}{10^8} = I$	·00000546			
Reactance per segment—ohm—$(2 \pi n I)$	·024			
Number of sets of brushes employed (for wave winding)	Lap winding			
Min'm series reactance of short-circ. send's. (wave winding)	2·5			
Reactance volts—volts	2·5			
Pole arc ÷ polar pitch	·64			

Sheet VIII.

Dimensions (continued).	A	B	C	D
Collector Rings: Diameter	380			
Number of rings	6			
Width of each ring	40			
Useful width of each ring	40			
Total depth of each ring (radial)	—			
Distance between rings	—			
Total length of collector	350			
Collector Ring Brushes: Number of sets	6			
Number of brushes per set	6			
Length of each brush	—			
Width of each brush	19·5			
Thickness of each brush	—			
Length of the arc of contact	31			
Contact surface per brush (sq. cms.)	6·0			
Material of the brushes	Copper			
Brush designation	—			

Sheet X.

Electrical and Magnetic Data (continued).	A	B	C	D
Resistance of all conductors in series at 20° Cent.	·29			
Per cent. increase in resistance per degree Centigrade	·4			
Per cent. increase in resistance from 20° to 60° Cent.	16			
Resistance of winding from + to − at 20° Cent.	·0045			
Resistance of winding from + to − at 60° Cent.	·0063			
C.R. loss in armature at 60° Cent. (volts)	3·1			
C.R. loss in the series-spools at 60° Cent. (volts)	0·9			
C.R. loss in the brush contact surfaces (volts)	2·0			
Further C.R. loss—(volts)	—			
Total internal C.R. loss—(volts)	6·0			
Cross section of the armature conductor (sq. cms.)	·187			
Amperes per armature conductor	74			
Cross section of the commutator connection	·09			
Amperes per commutator connection	0 to 70			
Cross section of the collector ring connection	·38			
Amperes per collector ring connection	110			
Cross section of the commutator brush contact surface	4·2			
Amperes per commutator brush	20·5			
Cross section of the collector ring brush contact surface	6·0			
Amperes per collector ring brush	109			
Cross section of the shunt winding conductor	·03			
Amperes in the shunt winding	9·3			
Cross section of the series winding conductor	[illegible]			
Amperes in the series winding	[illegible]			
Cross section of the series winding diverter conductor	[illegible]			
Amperes in the series winding diverter conductor	[illegible]			
Amperes per square centimetre in armature conductor	396			
Amperes per sq. cm. in commutator connection	800			
Amperes per sq. cm. in collector ring connection	400			
Amperes per sq. cm. in commutator brush contact surface	5			
Amperes per sq. cm. in collector ring brush contact surface	18			
Amperes per sq. cm. in shunt winding	127			
Amperes per sq. cm. in series winding	[illegible]			
Amperes per sq. cm. in series winding diverter conductor	[illegible]			
Cross section of slot	333			
Total cross section of copper in slot	150			
"Space factor" of slot	0·45			

Sheet XII.

Magnet Circuit.	A	B	C	D
Flux entering armature per pole—no load—megalines	1·48			
Corresponding voltage	120			
Flux entering armature per pole—full load—megalines	1·50			
Corresponding internal voltage	120			
Corresponding terminal voltage	120			
Leakage factor	1·125			
Flux generated per pole—no load—megalines	1·61			
Flux generated per pole—full load—megalines	1·69			
Armature: Cross section of the core (sq. cms.)	63			
Density—no load—c.g.s. lines	11400			
Density—full load—c.g.s. lines	12000			
Ampere-turns per cm.—no load	6			
Ampere-turns per cm.—full load	7			
Magnetic length per pole—cms.	10·5			
Ampere-turns—no load	63			
Ampere-turns—full load	74			
Teeth: Number of teeth per pole	10·5			
Number of teeth directly below a mean pole arc	6·7			
Percentage increase allowed for spread	20·5			
Total number of flux-carrying teeth per pole	8			
Total cross section at the bottom of these teeth (sq. cms.)	65			
Apparent density—no load—c.g.s. lines	21800			
Apparent density—full load—c.g.s. lines	23000			
Mean width of tooth—mm.	12·05			
Width of slot—mm.	19·1			
Mean width of tooth + width of slot	1·0			
Corrected density—no load—c.g.s. lines	20600			
Corrected density—full load—c.g.s. lines	21300			
Ampere-turns per cm.—no load	406			
Ampere-turns per cm.—full load	580			
Length—cms.	2·75			
Ampere-turns—no load	1100			
Ampere-turns—full load	1480			
Air Gap: Cross section at pole face (sq. cms.)	187			
Density at pole face—no load—c.g.s. lines	7700			
Density at pole face—full load—c.g.s. lines	8000			
Length of air-gap—iron to iron—cms.	0·4			
Ampere-turns—no load	2420			
Ampere-turns—full load	2950			

the firms. A moderate initial outlay in preparing an orderly set of fairly complete specifications, and a further small outlay for its maintenance, will time and again be saved in the promptness and certainty with which the performance of machines may be stated, and in the greatly decreased number of cases in which such mistakes as those referred to, will be made as to saturation, compounding, &c.

On the first sheet are given data relating to the rating of the machine. Sufficient space is arranged to provide for any one of three types, namely, dynamos, motors and rotary converters. Thus, for the case of a dynamo or motor, the spaces relating to collector rings are left blank. For illustrating the use of the specification, the design of a 100-KW. six-phase rotary converter is indicated in column A.

Sheet 2 is devoted to lists of drawings, constructional specifications, test reports, connection diagrams, &c.

On sheets 3 to 8 inclusive, are given the mechanical dimensions, and these are so arranged that sheets 3 and 4 relate exclusively to the armature, 5 to the frame, 6 to the magnet spools, 7 to the commutator and 8 to the collector. Sheet 8 would only be required for rotary converters. These six sheets would for completed machines be filled out in the drafting office.

Sheets 9 and 10 relate to the electric and magnetic design in general, sheet 11 to the sparking constants, and sheets 12, 13 and 14 to the design of the magnetic circuit. Sheets 15 and 16 are devoted respectively to the shunt and series winding calculations.

(To be concluded.)

Sheet XIII.

Magnetic Circuit (continued).	A	B	C	D
Magnet Core: Cross section—(sq. cms.)	118			
Magnetic length—cms.	13			
Density—no load—c.g.s. lines	14,200			
Density—full load—c.g.s. lines	14,900			
Ampere-turns per cm.—no load	14			
Ampere-turns per cm.—full load	16			
Ampere-turns—no load	210			
Ampere-turns—full load	240			
Yoke: Cross section (without allowance for ribs)—sq. cms.	135			
Magnetic length—per pole—cms.	22			
Density—no load—c.g.s. lines	6,000			
Density—full load—c.g.s. lines	6,350			
Ampere-turns per cm.—no load	34			
Ampere-turns per cm.—full load	37			
Ampere-turns—no load	750			
Ampere-turns—full load	810			
Ampere-Turns per Spool—No Load				
Armature core	63			
Armature teeth	1,100			
Air gap	2,420			
Magnet core	210			
Yoke	750			
Total number of ampere-turns per spool—no load	4,543			
Corresponding voltage	130			
Ampere-Turns per Spool—Full Load				
Terminal voltage	130			
Internal voltage	136			
Armature core	74			
Armature teeth	1,430			
Air gap	2,850			
Magnet core	240			
Yoke	810			
Total number of ampere-turns per spool—full load	5,194			

Sheet XIV.

Armature Interference.	A	B	C	D
Armature ampere-turns per pole	Rotary Converter			
Number of segments of brush shift				
Percentage brush shift				
Percentage of demagnetising turns				
Demagnetising turns per pole				
Distorting turns per pole				
Summary.				
Ampere-turns per field spool with no arm. current for uniform flux distribution	Shunt wound rotary converter			
Ampere-turns per pole to overcome arm. demagnetisation				
Ampere-turns per pole to overcome distortion				
Total ampere-turns per pole—full load				
Ampere-turns per shunt spool—no load	4543			
Ampere-turns per shunt spool—full load	5194			
Ampere-turns per series spool—full load	No series			
Experimental Observations on Brush Shifting.				
No load—No. segments max. brush shift without sparking	Rotary converter Armature always in neutral position			
No load—Percentage max. brush shift without sparking				
Full load—No. segments min. brush shift without sparking				
Full load—Percentage min. brush shift without sparking				
¼-load—No. segments shift for most sparkless running				
¼-load—Per cent. shift for most sparkless running				
Full load—segments do.				
Full load—per cent. do.				
50 % overload—segments do.				
50 % overload—per cent. do.				
100 % overload—segments do.				
100 % overload—per cent. do.				
Best fixed brush position for all loads—segments shift				
Best fixed brush position for all loads—per cent. shift				

Sheet XV.

Spool Winding, Shunt.	A	B	C	D
Preliminary calculations: Mean length of one turn in metres (a)	·35			
Ampere-turns per shunt spool—full load (b)	5124			
Ampere-turns × metres (a × b)	2830			
Cylindrical surface per spool—square decimetres	10·5			
Permissible loss per square decimetre—watts at 60° C.	10			
Loss per spool—watts at 60° C.	105			
Loss in shunt winding—per spool—watts at 60° C.	105			
Loss in series winding—per spool—watts at 60° C.	No series			
Shunt copper per spool—(Kgs = $\frac{\text{watts} \times a^2 b^2}{\text{Watts at } 60^\circ \text{ C.}}$)	13·3			
Terminal voltage—full load	120			
Volts drop in rheostat in per cent. of total voltage	25%			
Voltage at terminals of shunt winding at 60° Cent.	90			
Voltage at terminals of one shunt spool at 60° Cent.	11·25			
Amperes per shunt spool	9·3			
Turns per shunt spool	550			
Total length of shunt conductor—metres	306			
Kilogrammes per 1000 metres	42·0			
Gauge number of shunt conductor	—			
Bare dimensions of shunt conductor. *Diameter*	2·5			
Insulated dimensions of shunt conductor. *Diameter*	2·6			
Cross section in square centimetres	·0495			
Amperes per square centimetre	190			
Available length of winding space	135			
Number of layers	12			
Turns per layer	46			
Resistance per spool at 20° Cent.	1·04			
Resistance per spool at 60° Cent.	1·21			
Resistance of all spools at 60° Cent.	9·7			
Watts lost per spool at 60° Cent.	105			
Watts lost in all spools at 60° Cent.	840			
Finally determined weight of copper in one spool	12·9			
Finally determined weight of copper in all spools	91			
Total cross section of copper per spool (sq. cms.)	27·2			
Space factor for shunt spool	4			

Sheet XVI.

Spool Winding, Series.	A	B	C	D
Ampere-turns (series)—full load	The same as in Sheet XV—Shunt-wound Rotary Converter.			
Total amperes of the machine—full load				
Amperes in the series diverter rheostat				
Amperes in the series winding				
Turns per spool (series)				
Dimensions of the conductor				
Number in parallel				
Total cross section				
Amperes per square centimetre				
Mean length of turn				
Total length of conductor per series spool				
Resistance per spool at 20° Cent.				
Resistance per spool at 60° Cent.				
Watts lost per spool at 60° Cent.				
Cylindrical surface—square decimetres				
Watts lost per square decimetre at 60° Cent.				
Resistance of all series spools at 60° Cent.				
Watts lost in all series spools at 60° Cent.				
Weight of copper per series spool				
Total weight of series copper				
Total cross section of copper per series spool				
Total cross section of winding space per series spool				
Space factor of the series spool				

COMMUTATION.

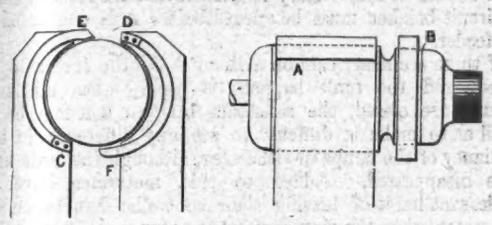
By H. ST. HILL MAWDSLEY.

The problem of obtaining sparkless commutation in continuous current machines has been brought very much to the fore of late, and with reason, for it is not too much to say that the future of the continuous current generator depends upon its satisfactory solution.

It is certain that alternating current machinery will be much improved in the near future, and if the dynamo is to hold its own it will only be by particular attention being paid

to the one point (disregarding questions of transmission) in which it is inferior to its alternating current rival, that is, in the collection of current. If commutation can be still further improved there is no reason why continuous current cannot be generated at much higher pressures than are at present feasible, and we shall then be able to transmit power by continuous current as favourably or nearly as favourably as by alternating and polyphase systems.

Even now dynamos and motors are made working at pressures up to 2,000 volts, and the writer has designed



Note.—The distance pieces C and D should appear on the right-hand figure, from which they were accidentally omitted.

Fig. 1.

dynamos with closed coil armatures for a pressure of 2,500 volts, which were as satisfactory as machines at much lower pressures.

Several methods have been proposed for improving commutation, perhaps the best and most satisfactory way being to keep the reactance voltage of the coil undergoing commutation as low as possible (the method developed and advocated by Mr. Hobart). This really means that the armature is designed so that it only requires a small amount of energy to reverse the current in the short-circuited coil. If to do this a large amount of energy is required, then commutation will be unsatisfactory unless the requisite energy is supplied to the coil itself. As it is difficult to obtain economically a low reactance voltage or commutation energy with large machines at high voltages, it is necessary to consider the best way of supplying the required energy to the short-circuited coil. At present the only way of doing this is to utilise the magnetic field of the dynamo to create a reversing voltage in the coil, either by the direct action of the field on the coil itself, or by means of other coils in series with the short-circuited coil, as in the Sayers winding, the objection to the latter method being that the armature is rendered more complicated and expensive.

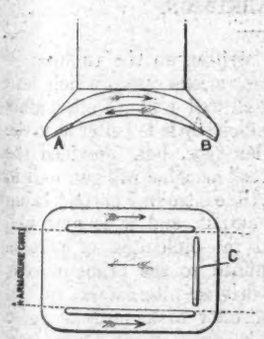


Fig. 2.

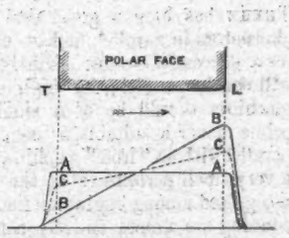


Fig. 3.

To reverse by the direct action of the field, the induction at the trailing pole tip should not be less than a certain value, depending upon the reactance voltage of the armature coil; and as this reactance voltage increases with the load, the induction should also increase. Unfortunately, the greater the current through the armature and the greater the need for a strong reversing field, the more is the field distorted by the cross-magnetising power of the armature and the induction at the trailing pole tip weakened.

Hitherto it has been necessary to reduce the distortion of the field as much as possible, either by increasing the polar induction and lengthening the air gap, or by opposing or throttling the cross flux. A longer air gap means that the machine will be heavier and more costly, and if the polar induction be increased, the hysteresis and eddy current losses in the armature will also be increased. The cross flux can be throttled or opposed by slotting the pole-pieces so as to increase the reluctance of the cross path, or by shaping the leading pole tip so that it is saturated at no load. The latter method, however, does not altogether prevent distortion, as it only increases the reluctance of the leading pole tip, the cross flux having, as it were, full play at the trailing tip and the greater portion of the polar area.

A method of utilising the increased magnetic potential at the leading pole tip occurred to the writer some time ago.

If we provide a path from the leading to the trailing pole tip, such path being arranged so as to be unaffected by the cross ampere-turns of the armature, then as soon as current passes through the armature, lines of force will flow from the leading pole tip through the connecting piece to the trailing tip, thus increasing the reversing field. The writer's firm, to prove this, made a dynamo as shown in fig. 1. The armature winding was carried over a short core B at about 1 in. from the main core A.

Wrought-iron strips were bolted on to the magnets at C and D, the leading pole tips, and carried round to the trail-tips or neutral zone at E and F, so as to form small poles acting on the armature winding over the small core B. This machine gave very good results, the output with sparkless collection being much increased. The auxiliary poles, however, did not improve the appearance of the machine, and this, together with the extra cost of building up the armature, did not seem to be compensated sufficiently by the saving in copper and iron.

A pole-piece which does not detract in any way from the appearance of the machine, and which does not appreciably increase the prime cost, has been devised by my assistant, Mr. J. W. Burleigh. This pole shoe as applied to a multipolar machine is shown in fig. 2.

Two connecting pieces or bonds of iron or steel connect the pole tips, the bonds being separated from the pole shoe proper by about $\frac{3}{4}$ in. air space, so that the armature current does not influence the flux in the bonds. The magnetic potential at A being higher than the potential at B, due to the combined influence of the field and armature ampere-turns, lines of force will flow through the bonds, as shown by arrows in fig. 2, equalising or tending to equalise the flux over the pole shoe, thus increasing the induction at B. The resulting line of induction will be approximately as shown by the line C C in fig. 3, where A A represents the induction at no load and B B the induction at full load with the ordinary type of pole shoe.

The return flux through the bonds may be concentrated at the trailing tip by slotting the pole shoe, as shown at C (fig. 2).

It seems to the writer that these equalising poles, as they may be termed, will go a long way towards neutralising the evil effects of the cross-magnetising power of the armature, and will enable sparkless commutation to be obtained even with a large number of armature ampere-turns and high reactance voltage.

INDICATION OF FAULTS ON FEEDERS.

Mr. M. B. Field, in a paper read before the B.A. at Belfast, stated that the general practice in tramway power stations, when a feeder circuit-breaker opens, is to close it again immediately, and to do this three times in all before assuming that there is a fault on the line. The line is then searched till the fault is located. It is fairly common practice, where no special instruments are installed to show when the line has been cleared, and where the system of telephonic communication is imperfect, to have the breaker closed every three to five minutes, after the fault has been searched for about 10 minutes, until it stays in, thereby indicating that the fault has been removed. As Mr. Field says, all this is crude in the extreme; and many engineers—to say nothing of the manufacturers—object to having dead shorts repeatedly plugged on to their machines. Occasionally the machines object, too.

Mr. Field then proceeded to describe a novel form of indicator (Electrical Review, Vol. 51, p. 600) shown in the accompanying diagram, fig. 1.

The *Street Railway Review* for October contains a very bad description of a very similar arrangement. The writer instructs you in the first place to "take" a Weston illuminated dial ammeter, and to cut it about in various ways to make it suitable for its new duties. Of course if you can "take" such an instrument when no one is looking, the cost will be

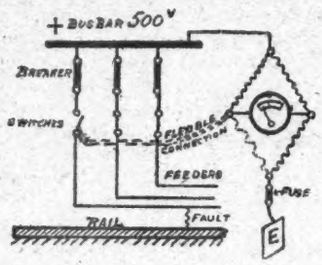


Fig. 1.

small; but, although we can thoroughly recommend the device as ingenious and serviceable, we should consider it very much better to get a special instrument made for the job.

Fig. 2 shows the diagram of connections; A C and A B are equal arms of a bridge across which the instrument is connected. The four lamps between the positive bus and A simply form an extraneous resistance. The point G is connected permanently to the grounded negative bus, H being a flexible cable for plugging any feeder. C G and B H are of equal resistance. If the switch S is closed while H is free, there is an unbalanced drop from A to C, the needle swings over to the right, and the left-hand lamp glows, this being the indication of a clear line. If H is plugged on to a dead short, the system is in balance, the needle remains stationary, and the lamps on both sides of the instrument glow. By

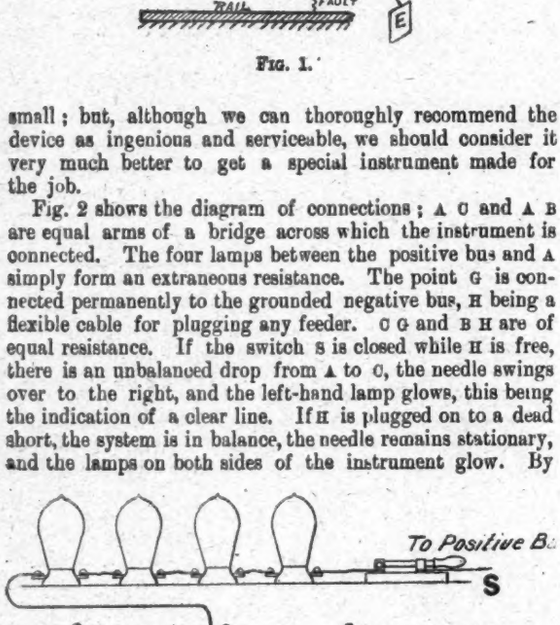


Fig. 2.

properly calibrating the instrument, the needle can be made to show the approximate resistance of the fault, and, with a little practice, the station attendants will soon learn to diagnose a fault. With such a device at hand, the machines need not be called upon to open the circuit-breaker at their own expense except when the fault comes on, as the breakers will not be replaced till the instrument shows all clear.

For those engineers who do not care to ask their directors, or their committee, to buy a fairly expensive instrument, we should recommend the use of the lamp system, connected as in fig. 2, without the instrument.

They will then have to rely on the intensity (from nothing up to full brilliancy) of the four lamps between A G and A H.

It is necessary to have two lamps on each leg, as, when H is connected to a fault, there are two series of a pair of lamps in parallel, this halving the resistance; and, if H is left connected to the feeder when the feeder is switched on to the bus-bar, the effect on the four lamps will not be so disastrous as if the 500 volts had been switched on to two 100-volt lamps.

It should be unnecessary to remark that the feeder switch or circuit-breaker must be opened before H is connected to the feeder.

If there are many cars on a line fed by the feeder to be tested, and the fault happens at night, when all lamp circuits are closed, the resistance between G H may be so small as to make it difficult to see any difference in the brilliancy of the lamps in either leg, although the fault may have disappeared. Added to this, motormen have an unpleasant habit of leaving their controller handles on the first notch when the circuit breaker opens, so that they may lose no time in starting. Therefore, even when the instrument is used, the reading may be so high as to indicate a serious fault when none really exists. It is hopeless to expect any apparatus to deal satisfactorily with that kind of thing, and the only cure is to make it unpleasant for the motormen.

Whether generators are designed well enough not to flash round on a short or not, without a doubt no generator, or engine for the matter of that, is improved by constantly recurring stresses of this description, and some device of the simple and inexpensive nature mentioned above should be found in every traction station. No complicated movements, adjustments, or calculations are required, and any engineman or switchboard attendant can operate it just as well as a highly-trained engineer. If the instrument were made sufficiently sensitive, and with a carefully divided scale, it might be used with advantage for the actual location of a cable fault; at all events as a preliminary to the use of the usual testing apparatus.

ON THE GOVERNING OF ENGINES FOR ALTERNATING CURRENT SUPPLY.

By G. R. J. PARKINSON.

There has been a great deal written on the running of alternators in parallel, and on the various causes which lead to a successful result. Nearly all well designed alternators will run in parallel; for high efficiency it is better that the machines should be of a similar type, but, provided the prime mover is suitable, a "copper" machine will run well in parallel with an "iron" machine, the controlling current being a very small percentage of the output, and it is now well recognised among engineers that the difficulties of parallel running are almost entirely confined to the prime movers. The most general method of driving alternators in this country is to connect them directly to a medium speed engine, and the following remarks apply more particularly to this case:—

Suppose two alternators, A and B, are running in parallel on a given load, and suppose that from some cause machine A momentarily lags behind B, the electrical result is, that A drops part of its load, and, assuming that the engine continues to give out the same power, A accelerates; as soon as A has caught up to B, it resumes its fair share of the load, and engine and alternator are balanced; but the momentum accumulated in the fly-wheel whilst A was accelerating carries it beyond its normal position relative to B, and A starts to lead, the reverse action at once takes place, A takes more than its share of the load and is retarded, and an oscillation between the two machines is thus set up. This oscillation has a definite time of vibration depending on the moments of inertia of the fly-wheels. Now, providing the turning moments are good, and the engines continue to give constant power, these oscillations are quickly damped out

by the eddy currents induced in the field poles, and in the case of laminated poles, special copper damping coils are provided for this purpose.

In the preceding remarks I have assumed two things. First, that the turning moments of the engines are good; secondly, that the engines give out constant power during the oscillations. Good parallel running can only be obtained when these conditions are fulfilled.

With regard to the turning moments of the engines, except with three-crank engines, steam turbines, &c., it is impossible to obtain anything like a perfectly even turning moment; but by careful adjustment of the steam distribution, and by providing a sufficiently heavy fly-wheel, it is quite possible to get a turning moment sufficiently good for excellent parallel running with two-crank compound engines at speeds as low as 100 revolutions per minute.

I mentioned just now that if an oscillation is set up between two machines, it has a definite time of vibration, and it is quite evident that if this periodic time is equal to, or is a multiple of, the periodic time of the uneven turning moments of the engines, this oscillation may be enormously magnified in the same way as a pendulum is set swinging, by a succession of small impulses applied at the right moment.

The second condition, that the engine should give out constant power, depends on the governor, and is a frequent source of trouble. I have often seen it stated in text-books that the engines of machines running in parallel should not be separately governed; this is no doubt a way out of the difficulty, but a very clumsy one, and there is no reason why a suitable governor should not be used. For ordinary central station work it is usual to make a governor with a speed variation of from 3 to 4 per cent. between no load and full load, an auxiliary adjusting spring being added to bring the engine to normal speed at all loads. Such a governor will not work satisfactorily in parallel unless it is of a slow-acting type; with quick-acting governors, *i.e.*, governors controlled by strong springs, and having small inertia, it is necessary to give the governor a much wider range, the variation of speed between no load and full load being about 6 or 7 per cent.

For lighting work, where the load comes on and goes off gradually, this is perfectly satisfactory, as the engine driver can alter the adjusting spring as the load comes on, and maintain the engine at normal speed; but where sudden changes of load occur, as in stations supplying tramways, this big drop in speed is a serious disadvantage, and it becomes necessary to provide a governor with a smaller variation.

Now the reason why a quick-acting nearly isochronous governor is not suitable, is that when an oscillation is started between two engines in parallel, the governor is so sensitive, that it responds to the small speed variations, and when one engine lags, it is first relieved electrically of part of its load, and at the same time the governor gives it more steam, with the result that it is rapidly accelerated, and rushes past its normal position relative to the other engine, the opposite effect occurring when it is in a leading position. The combined effect of electrical and mechanical forces sets up a most serious oscillation, and even if the machines do not actually drop out of step, the bus-bar volts are seriously affected.

I think it will be quite evident from the above, that a suitable governor for parallel running should either be very far removed from isochronous, having, say, 6 or 7 per cent. drop, or when sudden changes of load occur, the governor may have a smaller drop, say, 3 to 4 per cent., but must not be too quick in action; this effect can be obtained by providing a spring governor with a powerful dashpot, or by using a dead weight governor with considerable inertia in its moving parts.

The slow-acting type of governor will not, of course, so quickly respond to changes of load, and trouble may be experienced from this cause, but there is undoubtedly a happy medium, and I have seen dead weight governors with a drop of 4 per cent. between no load and full load, which ran excellently in parallel, and which, when full load was suddenly thrown off, only showed a momentary rise of 7 or 8 per cent., settling down almost immediately to 4 per cent. above no-load speed.

CORRESPONDENCE.

Tramcar Brakes.

I have been much interested in your excellent articles appearing recently on the "Tramcar Brake Question," and quite agree with you that it is the human element that is usually at fault. Might I suggest to traffic managers, that drivers should be put through a similar training to that given by the railway companies, before a man finally attains the position of "express driver." I do not think sufficient weight is given to the fact that the driver of an electric tramcar, to have no accidents over a long period, must be a man with considerable nerve, and, for that reason alone, his physical constitution should be taken into account. The railway course to which I refer is briefly as follows:—A young man desiring to become an engine driver, first enters the cleaning sheds, where he is made familiar with all the apparatus on the locomotive, brakes, &c.; he is then promoted, perhaps, after a year or two, to a "goods fireman," then a passenger fireman, and, provided his character be satisfactory all through, to a passenger express fireman; next he enters the driving stage, following the same course, viz., goods, passenger, passenger express driver. You will thus see that the railway companies adopt a most excellent plan of only allowing men of mature experience to undertake responsibilities, which are apparently given to drivers of tramcars after a *few weeks'* trial. I do not suggest that the course in driving tramcars should be quite so elaborate, because the responsibilities are far less, but I would point out that the dangers of driving an electric tramcar along a crowded road where traffic is continually crossing and re-crossing the rails, and where there are no signals to warn the driver of danger, are certainly not to be ignored. Again, I have found from experience, you may provide all kinds of safeguards for men to use, but, if they do not use these safeguards continually, it will be the last thing they will use on an accident, owing to the loss of nerve. I have found it essential, especially in dealing with high-tension works, that all safeguards should be continually practised, and not left until an accident occurs.

Human nature is sure to do the thing which it is most accustomed to in an emergency.

Apologising for trespassing on your valuable space.

Horace Boot,
Consulting and Resident Engineer.

Tunbridge Wells Electricity Works,
November 26th, 1902.

Starting and Stopping Turbines Electrically at a Distance.

With reference to the correspondence which has recently taken place on this subject, I might mention that the starting and stopping of the turbine at Cragside at a distance of half a mile was one of the first problems which I had the pleasure of working out with the late Lord Armstrong, and the story connected with this may be worth placing on record.

When staying at Cragside in connection with the rearrangement of the original installation, which had bare wires under the floors, Lord Armstrong discussed the possibility of starting and stopping the direct-running plant which was then used for the lighting of a portion of the house. I told him I could arrange the electrical portion if he would do the hydraulic gear.

As an instance of his energy, I may say that this discussion occurred just before going to bed, and at an early breakfast the next morning he placed on the table a drawing of the hydraulic gear to scale, and asked how my electrical part was getting on! By lunch time I had completed the drawings, and two powerful electro-magnets actuating an armature in both directions were afterwards made by Messrs. Crompton & Co.

On delivery Lord Armstrong reported that the apparatus worked well in one direction, but not in the other.

My next visit to Cragside nearly resulted in a dramatic ending for both of us. We were engaged in testing the

apparatus which was placed on a table between us, and I had just altered the connection to the coils, which I found had been incorrectly made, when a loud report took place and there was a burst of flame between us. Immediately afterwards some men ran in to say that the overhead wires above the turbine house had been struck by lightning, and on examination we found it had gone to earth on a water pipe between us, producing considerable fusion. Fortunately, however, beyond the fright we were neither of us any the worse.

The apparatus worked successfully for some years, but I eventually had to add accumulators, which rendered its further use unnecessary.

Another story connected with Lord Armstrong relates to his Scotch terrier, which was of an inquisitive nature, and given to upsetting his experimental apparatus. On one occasion the dog was investigating the properties of a charged Leyden jar, when the results can easily be imagined. For years that dog would lie down at a distance from the laboratory, and nothing would induce him to accompany his master any nearer.

B. M. Drake.

Students' Difficulties, and Apprentices.

There has been a great deal of controversy upon the above-named subjects. I, for one, do not see how any rule or rules can be laid down for either student, gentleman apprentice or apprentice as regards tuition, as a great deal depends upon the persons themselves, some being quicker at picking up information, and some being keener on their work. A majority of gentlemen apprentices miss good opportunities, whereas apprentices *have* to take them.

Gentlemen apprentices have to go through, say, seven or eight shops in three, four, or five years, consequently changing shops so soon they do not have time to thoroughly learn the work, while the apprentices are (as I have known) in one shop sometimes over a year, and therefore do not have to go through the same amount of work. Another thing is that gentlemen apprentices are not forced to do such and such a job, or they are able to (I believe it is termed) "square" the foreman, whereas apprentices have to do it or go; that is the reason, I should say, of an apprentice re-doing gentlemen apprentices' work, as suggested in last week's Review by "Apprentice."

I also do not agree with him that gentlemen apprentices are more bother than they are worth, hindering men from working, as there have been, and are still known to be, such persons as "idle apprentices," and also as regards the hindering, it always takes two to make a bargain.

Gentlemen apprentices are usually looked down upon by the workmen, but at the same time they are found very useful when a workman is away ill, and also at Christmas, by both men and apprentices.

W. W. W.

Indication of Earths on Trolley Standards.

While recognising the general usefulness of the contribution in your issue of November 29th on "The Indication of Earths on Trolley Standards," and complimenting you on the practicality of so many of the articles appearing in the Review, there is one point in that contribution that should not pass without criticism. I refer to the suggestion that because in your experience no tramcar passenger has made a claim for damages occasioned by a shock from a faulty trolley standard, the public may therefore be exposed to the risk of such shocks, which, *pace* experiments shown before the I.E.E., have before now proved fatal. With a shorter experience than yours, I have known such a claim made, and not resisted. I took care that there should be no opportunity to make another on the line I am connected with. It should be the duty of a tramway manager to ensure to the utmost the safety of the public, even at the risk of occasional disorganisation of traffic if need be.

In the same article you criticise as crude, uncertain and complicated one of the very simplest of electro-mechanical devices, the ordinary shutter indicator. If you will more carefully examine this "complicated" apparatus, you will find it to consist of three parts, solenoid, armature and pivoted flag. As the current to actuate it will be relatively large, the parts may be substantially made and the action absolutely reliable. And why an electric bell in connection with this device should be unreliable, but quite satisfactory in connection with that favoured by you is not very clear. As to the necessity of pushing the cripple home, it is surely a simple matter, the passengers having being transferred, as in either case they would need to be, at least from the roof, for the authorised person, motorman or other, who alone should be allowed to interfere with any car, to open the earthing circuit by plug or switch, replace the trolley and run the car home in the ordinary way.

But the point I would emphasise is this, that lamps give an indication of the fault that can be and is overlooked by careless conductors, particularly in sunlight. A passenger can easily receive a shock before all can be cleared from the roof, and on a crowded car is likely to do so. An unnecessary risk is run where absolute safety can be secured at little cost to efficiency and at a trifling outlay. What is safest for the public, in reason, will soon prove itself best for the tramway authority.

And why should you attempt to be sarcastic about the "inventors" of this simple contrivance? No attempt has been made to patent or even to register it. I do not think the makers claim to have invented it, and I am sure the man who originally specified it does not call himself an inventor on that account.

Car Boy.

[We are sorry that we have hurt our correspondent's feelings; but why put a dead short on the line, when it can be avoided?—Eds.]

Indicator Diagram Paper.

I enclose a sheet of paper which is a sample of that used in one of the largest electric supply stations in the country for taking *indicator diagrams*. I have underlined the words indicator diagrams in case you should think it is ordinary sand paper. I should like your opinion of it through the Electrical Review.

Indicator.

[We certainly took the paper for some new kind of abrasive material before reading the above letter. How it is possible to obtain accurate diagrams on paper presenting such a harsh surface we do not know.—Eds. Elec. Rev.]

Mechanical Engineers for Electric Generating Stations.

I have followed with interest the correspondence on the above subject, and am greatly amused at the apparent conceit of "Mechanic," who has had good experience (with three engines), and wonders why it is he can't realise his ambition and get a "shift job" (which, by the way, is not much of a catch when he gets it). No doubt, with his "vast experience," he thinks there ought to be quite a rush for him by chiefs, but, no doubt, they are wise in thinking twice before they put such a man as "Mechanic" in charge of their stations, consisting, perhaps, of thousands of horse-power—which, by the way, are a little more exciting to run than a private three-set plant.

Picture "Mechanic" in charge of a shift in one of the large London stations on a winter's day, when a sudden fog comes on, and the load jumps up in hundreds of amperes in a very short period. I surmise that before he had finished "warming up his engines and taking the water off" to his satisfaction, the running set, or sets, would have "pulled up" in disgust at having so much load thrown on them without any help.

I do not see that the case he mentions of "A Young Electrical Engineer" helps his cause in any way, as we do not know the facts of the case or the qualifications of "A Young Electrical Engineer." Against his case I can state that I know of an "Experienced Mechanical Engineer" who got the job to look after a private plant, and when he started up at night after having been shown round in the day time, could not get any light, and so sent for the contractors, who came and found the only trouble was that the brushes were not on the commutator!

A Poor Shift Engineer.

Deterioration of Storage Battery Plates.

Referring to the article *re* above in your issue of 21st ult., I have not had the advantage of reading Prof. Marsh's article, but think some of Mr. Schoop's remarks thereon are open to criticism. Is it a fact that Continental makers supply negative plates with initially twice the capacity of their positives? It certainly is not the case here, and even were it possible to do this and compete in price with other makers, the advantage is very questionable, as the percentage of unused active material to the useful is thereby more than double, with all its ill effects. With a positive plate such a state of things would be immediately disastrous, leading to heavy sulphating and inevitable buckling.

I think also exception should be taken to calling the negative material "spongy lead." It is, or should be, not spongy lead, but lead in a finely divided state; real spongy lead is a very imperfect material for a negative plate, owing to the capillary nature of its interstices, and to the necessarily poor continuity.

This question of continuity is the crux of the whole problem. Pasted plates, in which the continuity is dependent solely on mechanical contact, are obviously theoretically imperfect, particularly when it is remembered that the active material is expanding and shrinking on every discharge and charge; a pasted plate also, from the nature of its surface, is subject to all the destructive effects of what I may, perhaps, call "strata" discharge and charge.

A Planté formed plate is a decided improvement in both these respects. It has a more readily accessible surface, it utilises a large percentage of its active material, and the continuity is better, but, it must be confessed, very little better excepting as regards the more intimate layers. Dealing with the Planté positive plate, the active material is here in the form of a thick scale, in a very similar condition to the rust on an iron pipe; but here again, unless one is content with a mere "skin" capacity with a prohibitive price, the "strata" effect is not eliminated, causing the outer layers to sulphate and disintegrate, except at very low current densities.

This is a recognised defect, and, at least with one well-known maker, the high discharge rate plates are merely their ordinary type plates "under-formed." A choice of evils.

There should be no distinction, except maybe in the matter of slightly heavier lugs and bars; a good high discharge rate plate is of necessity a good low discharge rate plate, and the reverse should hold true. With some so-called Planté formation processes, the peroxide is not produced in the crystalline form, but is of a muddier description, when it is only equivalent to electrolytically pasting.

Planté negatives are generally unsatisfactory; they deteriorate quicker even than the positives, due, probably, to the shrinkage in the active material (when reversed) having a stripping action. So it is that one finds the now general combination of Planté positives with pasted negatives, but the combination is far from ideal; the restricted surface of the negative plate at least is bound to have a detrimental effect on high rates of charge and discharge, and were a Planté negative of satisfactory nature forthcoming, much better results would be obtained.

I am far from wishing to condemn wholesale Planté and pasted plates, on the contrary, I wish to at once acknowledge that so much ingenuity and patient skill has been expended on their evolution that the old adage, anent the sow's ear, has become quite misleading, and such plates, with intelligent care, are daily doing useful work.

Perhaps a few words on intelligent care may be timely:—"Avoid discharging below the specified voltage." "Avoid charging at excessive rates and overcharging." These are fruitful causes of disintegration. How almost pathetic it is to see some makers advertising that their plates are mounted some impossible distance off the bottom of the cells to allow for "deposit." So it unquestionably does, but what about loss in capacity?

There is a plate on the market to-day which, in my opinion, approaches more nearly to the ideal plate than any other: in which the percentage of useful to idle active material is much higher; in which the surface is large and open; and the continuity nearly perfect. It is neither a Planté formed nor a pasted plate; but as I do not wish to use the valuable space of this paper for purposes of advertisement, I refrain from more particularly mentioning it. I only refer to it as I consider it important that so sweeping a statement as that with which Prof. Marsh closes his article should not go unchallenged.

There are certain well-defined limits to the possible capacity of a lead storage battery, it is true, and that these are closely approached in practice, and great improvements have been made in prolonging the useful life of these batteries, I know of my own experience.

There is no secret about the means to attain these ends. Just some process of formation, whereby, say, 70 per cent. of the active material in each plate can be utilised, instead of the 33⅓ per cent. of the Professor's experience.

Arthur E. du Pasquier.

Cardiff, *November 25th*, 1902.

INSTITUTION OF ELECTRICAL ENGINEERS.

Manchester Section.

A meeting of this section of the I.E.E. was held on Tuesday, November 25th. Mr. E. W. Cowan presided, and Messrs. R. S. Hutton and J. E. Petavel read a paper on "High Temperature Electro-Chemistry: Notes on Experimental and Technical Electric Furnaces." The paper is essentially technical, and should be of great service to those concerned in the equipment of electro-chemical laboratories, while the copious references are of value to any desirous of further investigating the subject. It is within the past 10 years that most of the important processes have been developed, the discovery of calcium carbide in 1892 giving a great impetus to the subject, and the provision of cheap electric power has stimulated the development. The reason for the little progress made in England, compared with that in Continental countries and America, is often attributed to the absence of water-powers, but the authors pertinently pointed out that the cost of power, in a great number of cases, is only a small percentage of the prime cost of the manufactured article; and that with high-efficiency steam plants, and the development of the gas engine, the cost of power in England should compare favourably with that of many of the water-power schemes; further, that the latter are often inaccessibly situated, thus raising the cost of freight on the raw material and the finished product.

A large number of electro-chemical products are absorbed directly in the iron and steel industries, and with the application of producer and blast-furnace gases, we should, in England, be most favourably situated for the production of these substances.

The paper is divided into two parts, Part I. dealing with the experimental equipment of a laboratory, Part II. being notes on technical processes.

In Part I. a resistance used for the exact regulation of large currents is described.—This has been found very reliable, and should be of great utility in test rooms.

The importance of purely scientific work is pointed out, for, though of no use for direct application in the immediate future, it may prove to be the starting point of notable advances, as has frequently been the case. In this direction a piece of apparatus is described for facilitating the determination of the effect of gaseous pressures on high temperature chemical phenomena, and it is proposed to carefully study some of the gaseous and other reactions, which may be expected to differ considerably from those occurring under ordinary working conditions.

A number of electro-chemical products were exhibited, those particularly interesting being electrolytic carbons and lead pencils.

There was practically no discussion. Prof. Arthur Schuster, F.R.S., pointed out the great difficulties of the subject. In the early days of electrical engineering no very great advance was made until mechanical and electrical knowledge were combined; again, with electro-chemistry, not only was mechanical and electrical know-

ledge required, but also a thorough understanding of the chemical problems, which could only be acquired after long and careful study. When we had men with these three qualifications, we might hope for more rapid advancement. It is very desirable that more should be known of the exact behaviour of processes at high temperatures, and with the experimental pressure furnace described, the authors were working at this subject, and would no doubt produce useful results.

Dr. Bowman said he had not a very great knowledge of the subject, being acquainted only with the manufacture of calcium carbide. One difficulty in making experiments, was due to the unreliable methods in use for the determination of high temperatures. He realised the importance to the industry of men having the combined mechanical, electrical and chemical training; such physical laboratories as that with which the authors were connected would be most useful in this respect, and in advancing the development of the industry. The lack of water-power in this country should not militate against such development here, because with more efficient steam and gas plants the power should be cheaply available; also, their location in the districts where the electro-chemical products would be utilised, would be important from economic considerations. He was watching with interest the chemical *versus* electrical processes for the manufacture of nitric acid.

In reply to a vote of thanks, the authors stated that they were indebted to Prof. Schuster for his foresight in having an electro-chemical laboratory included when the plans for the Owens College buildings were considered. The evening was concluded by adjourning to the laboratory, where some experiments were in progress, including the manufacture of:—(1) Calcium carbide; (2) carborundum; (3) pure chromium; (4) ferro-chromium; (5) ferro-vanadium.

LIGHT RAILWAY COMMISSION.

List of applications made to the Light Railway Commissioners in November, 1902, for orders authorising light railways:—

Title.	County.	Promoters.	Engineer.	Mileage.	Motive power.	Gauge.	Agents.
						Ft. in.	
1. Avonmouth	Gloucester ...	Philip Napier Miles ..	T Kirkland. D. S. Copper.	2¼	Steam or electric	4 8½	Torr & Co.
2. Callington (extension of time)	—	Light Railways Development Co., Ltd.	—	Extension of time.			Bircham & Co.
3. Dartford extensions	Kent	Dartford U.D.C. ...	W. C. C. Hawtayne	7¾	Electric	4 8½	Baker, Lees & Co.
4 Devonport Corporat'n	Devon	Devonport Corporation	C. Chadwell ..	1¼	Electric	3 6	Sherwood & Co.
5. Didcot & Watlington (Amend.)	—	Light Railways Development Co., Ltd.	—	Revival of powers and ext'ns'n of time		—	Bircham & Co.
6. Doncaster Corporation	Yorks	Doncaster Corporation	W. & R. Crabtree	1¼	Electric	4 8½	Sherwood & Co.
7. Dudley, Halesowen and District.	Worcester and Staffs.	Dudley, Stourbridge and District E. P. Co., Ltd. and B E T. Co., Ltd.	S. Sellon	3½	Electric	3 6	S. Morse.
8. Grimsby District ...	Lincoln	Gr. Central Railway Co.	C. A. Rowlandson	7¾	Electric	4 8½	Martin & Leslie.
9. High Peak District...	Chester and Derby	Derbyshire & District Traction Syndicate.	J. E. Waller ...	20¼	Electric	4 8½	W. & W. M. Bell.
10. Lambourn Valley ...	Berks	Lambourn Valley Railway Co.	J. S. Macintyre ...	For power to work existing railway as a light railway			Le Brasseur & Oakley.
11. Lastingham & Rosedale	Yorks ...	Lastingham & Rosedale Lt Rly Co.	C. Chadwell ...	Deviation and extension of time			F. C. Mathews & Co.
12. Mid-Suffolk... ...	Suffolk	Mid-Suffolk Lt. Rly. Co.	Jeyes & Godden	Deviation and extension of time			W. H. Smith & Son.
13 Newton Toney Curve	Wilts	L. & S.W Rly. Co. ...	J. W. J. Hood ...	¼	Steam ...	4 8½	S. Bircham.
14. North Lindsey ...	—	North Lindsey Lt. Rly Co.	—	Extension of time ...	...		W. Dodgson (Leeds).
15. Quarry Bank, Brierley Hill & Rowley Regis	Stafford and Worcester	Quarry Bank U D C, Brierley Hil U D C., & Rowley Regis U D C.	R. Wilson ...	3½	Electric	3 6	Baker, Lees & Co.
16. Ripon and District...	Yorks.	Power & Traction, Ltd.	R. A. Smith ...	4½	Electric	3 6	Baker, Lees & Co.
17. Rowley Regis ...	Stafford and Worcester.	Rowley Regis U.D.C....	R. Wilson ...	3¾	Electric	3 6	Baker, Lees & Co.
18. Rugby and District...	Warwick	O W. Bowen, E. Horton	Pritchard, Green and Co.	4½	Electric	3 6	Wm. Webb & Co.
19. Torquay and District	Devon	Power & Traction, Ltd	R. A. Smith ...	8	Electric	3 6	Baker, Lees & Co.
20. Totton, Hythe, and Fawley.	Southampton ...	L. & S.W. Railway Co.	J. W. J. Hood ...	10¾	Steam ...	4 8½	S. Bircham.

Total mileage, 7 ¼. Total estimate, £620,320

APPLICATIONS FOR ELECTRICAL POWERS.

The following is a further list of applications now filed for lighting, tramway, power and railway schemes:—

Electric Lighting (Applications by Companies)—Port Dinorwic (G. W. D. Assheton Smith); Whitchurch and Paignton (W. and P. Electric Supply Co.); Carisbrooke and Northwood (Isle of Wight E.L. and P. Co.); Auckland Rural (County of Durham E.P.D Co.); Illogan (Urban Electric Supply Co.); Bromley Rural District (Kent Electric Power Syndicate); Sittingbourne and Milton (Kent Electric Power Syndicate); Uxbridge and District (U. and D. Electric Supply Co.); Leatherhead and District (Dorking and Fetcham) (L. and D. Electricity Co.); Strood and Dartford (Kent Electric Power Syndicate); Sandwich, Deal, Walmer and District (Kent Electric Power Syndicate); Sevenoaks (Kent Electric Power Syndicate); Chipping Norton (W. V. M. Popham).

Electric Lighting (Applications by Councils)—Huddersfield; Dawlish; Braxham (Devon); Strood; Wigan Rural D.C.; L.C.C. (Electric Supply Bill, purchase of London undertakings); Launceston; Nantwich; Stafford (outside borough limits); Orrell; Huckn-al-under-Huthwaite; Aberaychan; Falmouth; Bedwellty; Portland; Bexley (East Wickham; Warnley; Horsforth; Wickham; Horbury; Southgate; Brumby and Frodingham; Calverley; Yeovil; Wimbledon (Merton); Newton-in-Makerfield.

Electric Tramways and Light Railways (Companies' Applications).—Gosport, Fareham, Porchester and Cosham (Portsmouth Street Tramways Co.); West Cumberland Electric Tramways Co.; High Peak District Light Railways (Derbyshire and District Traction Syndicate); Dewsbury, Batley and Birstal Tramways (B.E.T. Co); Belfast Street Tramways Co: Chatham and District Light Railways Co. (Rainham, Gravesend, Maidstone, &c.); South Shields, Sunderland and District B E T. Co); Nottinghamshire and Derbyshire Co.; Birmingham District (local Council and City of Birmingham and Midland Tramways, Ltd., and B.E.T. Co. re running over existing Birmingham lines, and various other powers); Preston and Horwich Tramways Co; Wakefield and District Light Railway Co; Dudley, Halesowen and District Light Railways Extensions (D.S and District E T. Co and the B E T. Co.); Luton, Dunstable and District Co.; Hastings Tramways Co.; Grimsby District Light Railway (Great Central Railway); Rochester, Chatham, Gravesend and Maidstone (Co.); Torquay and Paignton Tramways Co.; Rugby and District Light Railway; Torquay and District (Power and Traction, Ltd.); Leeds and Guiseley (London and Birmingham Trust).

Electric Tramways and Light Railways (Councils' Applications).—Devonport (light railway); Bournemouth (purchase of Poole and District E T Co., &c); L.C.C. (Tramways and improvements); Manchester; Worthing; Plymouth; Aston Manor (also powers re supply of fittings, and of energy in bulk to outside authorities); Salford; Kingston-upon-Hull; South Shields; Bradford; Exeter; Ramsbottom; Dartford; Leeds; Horsforth; Keighley; Quarry Bank, Brierley Hill and Rowley Regis (U.D.C.'s); Rowley Regis.

Electric Power and Railway Schemes—Carmarthenshire Electric Power Co.; Shropshire, Worcestershire and East Denbighshire Power Co.; Somerset and District Electric Power Co.; Baker Street

and Waterloo Railway Co. (various); Central London Railway (new lines and subways); Seaforth and Sefton Junction Railway Co.; Clapham Junction and Marble Arch Railway Co. (underground); London and Brighton Electric Express Railway (Co.); Taff Vale Railway Co.; City and Crystal Palace Railway Co.; Paddington, Victoria and Kennington Railway Co. (underground).

Miscellaneous.—L.C.C. (General Powers, including provisions re Borough Councils and supply of electric fittings).

The *Times* says that last Saturday was the latest time allowed by the Standing Orders for depositing at the private Bill office of the House of Commons, plans and other documents in connection with Bills for the making of local improvements to which Parliamentary sanction is necessary, and which are to be brought forward for consideration in the ordinary session of 1903. When the office was closed at 8 o'clock it was announced that there had been deposited 46 plans in connection with railways, 38 in relation to tramways, 60 miscellaneous, and 150 provisional orders, including tramways and electric lighting—total, 294. These figures may be compared with those of this time last year, which were—railways, 48; tramways, 23; miscellaneous, 73; provisional orders, including tramways and electric lighting, 174—total, 318. It is a remarkable fact that, though the totals under the different headings vary, the aggregate number of Bills (as distinct from provisional orders) is exactly the same this year as last year.

LEGAL.

The Patent Exploitation Co, Ltd., *v.* Siemens Bros. & Co.

In the Court of Appeal on Monday, Tuesday and Wednesday, before Lords Justices Vaughan-Williams, Stirling, and Cozens-Hardy the case of the Patent Exploitation Co., Ltd., *v.* Siemens Bros. and Co., Ltd., was heard on appeal of the plaintiffs from a judgment of Mr. Justice Buckley. The case was reported in the Electrical Review for February 7th, 1902.

Mr. Astbury, K.C. (with him Mr. Shaw and Mr. Paget), in opening the case, said his clients were the plaintiffs, and they appealed from the judgment of Mr. Justice Buckley in respect of an alleged infringement of certain letters patent granted to one Charles Addison Hitchcock, being No. 1,110, of 1890, the invention being for an improvement in galvanic batteries. The subject matter of the appeal was a simple one. The Court would not be troubled with scientific matters to any great extent. Mr. Justice Buckley had decided the matter substantially on the question of construction of the specification. Their Lordships would not be troubled with the question of infringement, because it was admitted that the plaintiffs' specification was good. Counsel then proceeded to go into the matter in great detail, and later said that Mr. Justice Buckley only "just" decided against the plaintiffs. His Lordship came to the conclusion that plaintiffs had not quite claimed all they had invented. He (counsel) contended that Hitchcock did a great work in a small way. The plaintiffs' case was that the learned judge had given an unnatural meaning to the specification, instead of allowing the words to have their ordinary fair significance. They said that if the learned judge had given the words of the specification their ordinary significance their invention was clear on the document. The point to be decided turned almost wholly on the question of construction. Learned counsel next dealt with the specification. The arguments were replied to by Mr. Fletcher Moulton on behalf of the defendants, and after considerable discussion between counsel and their Lordships, the hearing stood adjourned.

Dublin United Tramways Co. *v.* Fitzgerald.

The House of Lords has dismissed the appeal of the plaintiffs in this case, which has been reported and discussed in our columns from time to time. The company is held liable for keeping the part of the highway over which it has a qualified dominion in a state of safety, whether by sanding or any other effectual method.

BUSINESS NOTES.

New Publication.—The first number of the *World's Work*, the new 1s. monthly, edited by Mr. Henry Norman, M.P., and published by Mr. W. Heinemann, is a most excellent production. Educational matters are naturally very much to the fore, and other subjects discussed are municipal trading, the hindrances put in the way of trade by English railways, and American labour methods. The work abounds in articles of timely interest, and the pictorial side of the publication is very strong.

Hispano-American Electrical Society.—According to *La Energia Eléctrica*, Madrid, there has been formed a society bearing this name by a syndicate of American firms in different branches of the electrical trade, each of which has, for many years past, made a speciality of constructing a certain kind of articles. The above journal (organ of the association "La Industria Eléctrica en Espana") expresses the hope that this may lead to the recent advances of American industry becoming known in Spain, thus giving rise to a powerful development of the industry of that country.

Electrical Wares Exported.

Week ending Dec. 3rd, 1901.		Week ending Dec. 2nd, 1902.	
Adelaide	Value £342	Bangkok	Value £63
,, Teleg. apparatus ..	2,613	Bombay	382
Alexandria	296	Brussels	35
Buenos Ayres	459	Buenos Ayres	2,084
,, Teleg. cable ..	85	,, Teleg. mat. ..	100
,, Teleg. mat. ..	1,126	Calcutta	235
Calcutta	1,589	Cape Town	408
Cape Town	90	Colombo	79
Channel Islands	8	Durban	2,064
Chinde	79	,, Teleg. mat.	1,342
Copenhagen	260	Flushing	10
,, Teleg. wire ..	214	Hamburg	34
Durban	865	,, Teleg. mat.	76
East London	59	Hong Kong	25
,, Teleg. mat. ..	217	Kure	168
Fremantle	850	Le Treport. Teleg. mat. ..	200
Gothenburg	65	Melbourne	21
Lyttleton	65	Mossel Bay	12
Melbourne	400	Nagasaki	25
,, Teleg. mat. ..	342	North Atlantic. Teleg. cable ..	20,400
Ostend	220	Ostend	21
Port Elizabeth	213	Perth	219
Rio Janeiro	200	Port Elizabeth	65
Stockholm. Teleg. wire ..	67	Santiago	86
,, Teleph. mat. ..	148	Singapore	206
Sydney	757	Sydney	887
Tokio	49	Wellington	405
Valparaiso	60		
Wellington	91		
Total ..	£11,779	Total ..	£29,522

Foreign Goods Transhipped.

Durban. Telephones ..	Value	£87
New York, Elec. mat.		33
Total		£120

Figures Relative to Superheat.—In sending a circular of their superheater, Messrs. McPhail & Simpson point out that they use nothing but mild steel in construction, and solid-drawn pipes. They provide suitable thermometer pockets for temperature-taking, but in all their experience they have never found it necessary to provide a safety valve for a superheater. They also state their objection to the flooding of superheaters as liable to cause sediment and scale, and probably they are right. There must arise some deposit when flooding is done with impure water, and there is always present the liability of causing mishaps to the engines from forgetting to drain off the water. A sheet of some 20 results of various tests is given, showing a saving or extra efficiency, whatever this mean, of 16·8 to 51·5 per cent. The latter figure is very suggestive of steam previously very wet indeed. An average saving of 30·7 per cent. is claimed with an average superheat of 54·4° F., figures which require more explanation before we can accept them. Superheating by itself will not give such results as are claimed, and care ought to be exercised to differentiate between the economy due to superheat and that due to evaporating an excess of moisture carried over as priming. Figures given by Hutton as the probable economy from different degrees of superheat are quoted by Messrs. McPhail & Simpson. We abstract a few of them below, with the comment that the third column is of very little value—the saving in heat units is the essential consideration:—

Superheat. Fahr.	Coal economy. Per cent.	Steam economy. Per cent.
15°	10	12
30°	17	20
60°	22	25
100°	26	30
200°	35	40
300°	45	50

Football.—On Saturday, 22nd ult., the first of the annual football matches between the General Electric Co.'s head office, Queen Victoria Street, and the Robertson Lamp Works, Brook Green, took place at Wormholt Farm. The game was a very fast and furious one. The final result was the same as in several preceding years, the lamp makers managing to come off victorious by one goal to nothing. The return match is to be played some time in the beginning of the year.

Sunbeam Lamps.—The Sunbeam Lamp Co., of Gateshead, has secured a contract from the Midland Railway Co. for electric incandescent lamps for next year, also one for the whole of the requirements of the Liverpool Overhead Railway for six months. The same company also has in hand other large and important contracts from the General Post Office, and other departments of H.M. Government. We learn that at no time, since the beginning of the company in 1887, have the works been so busy and the orders so numerous. The company claims to have solved the difficulty of the high-voltage lamp question, and that the type it is now making is equally as satisfactory as the lamps for low-voltage circuits.

Electrical Developments.—Referring to the article by Mr. V. Ryan on the above-named subject which we recently published, the Bastian Meter Co. points out that the author's implied suggestion that all practical meters have a "revolving element," does not apply to its products; the latter represent one of the earliest forms of meter revived and perfected, and put in use to the number of 12,000. Moreover, these register the very smallest currents, whereas the company doubts whether motor meters of 40 amperes capacity will always start with a single 8-c.p. lamp, unless it be a 50-volt lamp.

Electrolytic Rectifier.—Under the name of "Nodon's Electric Valve," a practical form of aluminium cell is being introduced into this country, for the purpose of rectifying alternating currents, of which the following is a brief description. Mr. H. Snowdon, of 52, Queen Victoria Street, E.C., is the sole agent for the United Kingdom. The apparatus consists of

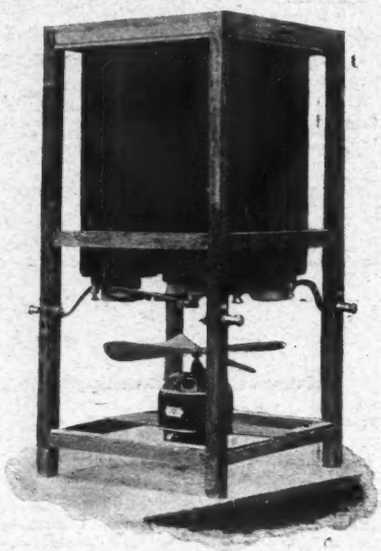


Fig. 1.—View of Complete Rectifier with Fan.

four cells, shown complete in fig. 1, each comprising a perforated iron tube, closed at the lower end by an insulating plug, and provided with a terminal; passing through the plug, concentric with the iron tube, is a cylinder composed of an aluminium-zinc alloy, and provided with a terminal. The whole thing is immersed in a saturated solution of ammonium phosphate. The action of the cell is based upon the formation of a film, stated to

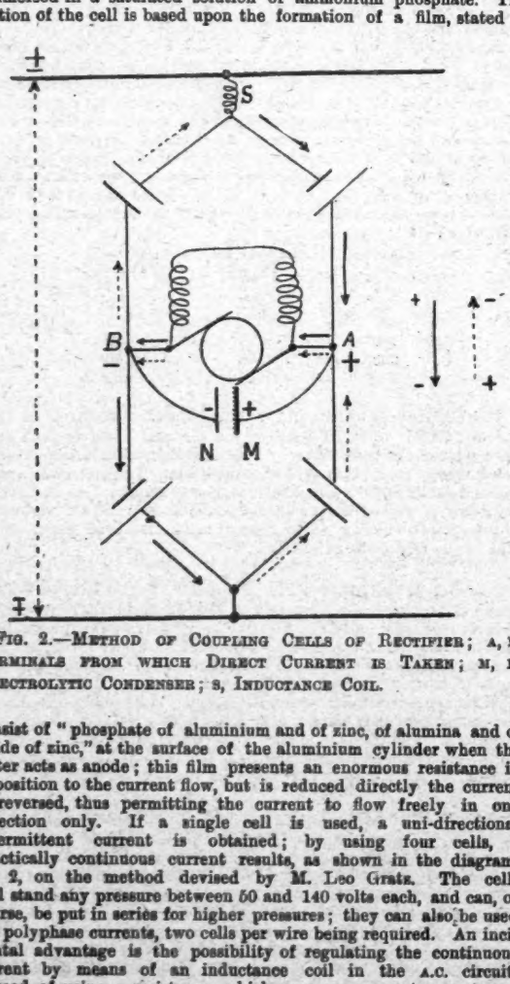


Fig. 2.—Method of Coupling Cells of Rectifier; A, B, Terminals from which Direct Current is Taken; M, N, Electrolytic Condenser; S, Inductance Coil.

consist of "phosphate of aluminium and of zinc, of alumina and of oxide of zinc," at the surface of the aluminium cylinder when the latter acts as anode; this film presents an enormous resistance in opposition to the current flow, but is reduced directly the current is reversed, thus permitting the current to flow freely in one direction only. If a single cell is used, a uni-directional intermittent current is obtained; by using four cells, a practically continuous current results, as shown in the diagram, fig. 2, on the method devised by M. Leo Gratz. The cells will stand any pressure between 50 and 140 volts each, and can, of course, be put in series for higher pressures; they can also be used for polyphase currents, two cells per wire being required. An incidental advantage is the possibility of regulating the continuous current by means of an inductance coil in the A.C. circuit, instead of using a resistance, which goes some way to counteract the loss of energy in the cells; the efficiency of the latter is 75 per cent., and can be maintained at this value by means of insulating sleeves slipped over the aluminium cylinders. The apparatus is independent of frequency, and does not exceed a temperature of 50° C. at normal full load. An example of the current curves, obtained by means of the Hospitalier ondo-

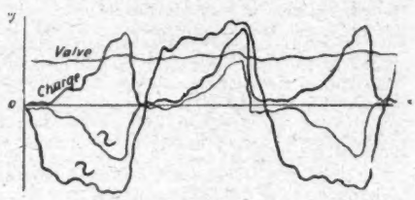


Fig. 3.—Rectified Current Charging Battery at 8 amperes.

graph, is shown in fig. 3. The current density on the aluminium surface is 5 amperes per square decimetre. The uses of the apparatus for charging accumulators, all kinds of electrolytic work, medical appliances, &c., are obvious. An electrolytic condenser, based on the same principle, is shown at M, N, in fig. 2.

Annual Dinner.—Messrs. Veritys, Ltd., Birmingham, held their annual works staff dinner at the Acorn Hotel on Monday, 1st inst. The chair was occupied by Mr. P. G. Ebbutt, managing director, supported by the works manager, Mr. G. O. Donovan. After the customary toast to the King, the chairman, in response to "The Firm," pointed out how in nine years the progress of the firm had been proved by a seven-fold increase in their output. The dinner was followed by a smoking concert.

Schulz Accumulators.—Messrs. Baker, Bauer & Co., of 3, Garden Street, Manchester, have taken up the agency for the Accumulatoren Werke E. Schulz, of Witten-on-Ruhr. In the cells made at these works the positive electrodes are deeply-grooved plates of lead with a strong core of solid metal, having a very large active surface; they can, therefore, stand very rapid and long discharges, and are suitable for use in generating stations for tramways, &c. In the positive plates the grooves are narrow, and are sub-divided for the purpose of obtaining a large active surface while reducing their weight and size as much as possible. They are formed by a Planté process, which is patented in all civilised countries. The negative electrodes consist of solid lead grids, having also a large extent of surface, which allows of the reception of a sufficient quantity of active matter. A special process is followed in the manufacture of the negative plates by which the spongy lead is made very porous, thus allowing every portion of the active material to take part in the working. The further precaution is taken to give the negative plates a larger capacity than would in the beginning be required, to prevent the decay and sulphating which might set in through bad treatment of the battery; yet the two types of plates correspond well with each other in their capacity, so that over-working the negative plates by an excessive utilisation of the large surface which the positive plates possess is impossible. The other extreme, of making the positive plates with so large a surface that they by far outlive the negative ones, and the former sulphate after a comparatively short time, is avoided. A special method of mounting the plates is employed, which, with other advantages, is claimed to ensure their satisfactory working, durability, and high efficiency. Batteries of this type have been installed at over 50 electricity works on the Continent.

E.P.S. Batteries.—The Electrical Power Storage Co., Ltd., has received orders for the supply of storage batteries from the War Office for the Stanhope and Marlborough lines, Aldershot; Bury Corporation; the Roundhay and District Electric Lighting Co., Ltd.; Roxburgh District Asylum, Melrose; North Riding Lunatic Asylum; and the Langho Asylum.

St. Louis Exhibition.—An excellent little pamphlet has been issued by Commissioner Parker (Sanctuary House, Tothill Street, S.W.) giving a fair idea of this Exhibition, its aims, and so forth, with views of the different buildings, maps, &c. All interested in the show can obtain copies on application at the above address.

Atlas Motors.—Messrs. Willans & Robinson, Ltd., have adopted Messrs. T. Harding Churton & Co.'s "Atlas" motors for driving centrifugal pumps by Messrs. Gwynne & Co., at the new works at Queensferry. The motors are specially arranged with vertical spindles running in ball bearings, but are in other respects of the makers' standard four-pole type, and shunt wound for 400 volts.

Düsseldorf Awards.—The Körting two-cycle gas engine, for the manufacture of which Messrs. Mather & Platt, Ltd. are licensees, was awarded two gold medals at the Düsseldorf Exhibition, one of these gold medals going to Gebrüder Klein for a 700 B.H.P. Körting engine made by them, and the other to the Siegener Maschinenbau Actiengesellschaft for a similar engine of 500 B.H.P.

Catalogues.—A batch of circulars and prints has come to hand from Messrs. Ernest Scott & Mountain, Ltd., describing some recent pumping, hauling, and power plants that they have completed in connection with collieries and works. Circular 25

describes a large pumping plant put down for Messrs. Blair & Co., marine engine builders, of Stockton; No. 26 describes an electrical winding gear completed for the Heckmondwike collieries; in No. 28 is an account of an electric power plant at the Normanby Ironworks Co.'s manufactories; No. 41 shows an electrical ventilating plant completed for the Mickley Coal Co.; No. 42 deals with electrical pumping, hauling, and lighting plant for the Tredegar Coal and Iron Co. for their Pochin Colliery; and No. 47 describes an electrical haulage plant supplied to the Consett Iron Co. for their Langley Park Colliery. The prints illustrate the firm's 300-KW. sets as recently installed for the Gloucester Wagon Co., their standard four-pole type dynamo, small electric pumping sets, multipolar Class S M. generator for coupling direct to high-speed engines, self-contained motor, electrically-driven winding gear as supplied to the Heckmondwike Collieries; also sundry haulage gearing, enclosed dynamos, pumps, motors, &c.

The third edition of the Improved Electric Glow Lamp Co.'s "Street Lighting" catalogue has been issued. It is an excellent production both in regard to general lay-out and printing. A variety of types of street standards, brackets and other fittings are well shown for arc and incandescent lighting; switch gear, automatic time switches, distribution accessories, and illumination photometers are described. The list is divided into three parts (1) relating to incandescent electric street lighting; (2) to arc electric street lighting; and (3) gives some general notes on the subject of street lighting.

A price list of Nernst electric lamps has been published by the Electrical Trades Supply, Ltd., of Cornwall Street, Birmingham.

Messrs Jones & Horsfield, of Broomstair Works, Denton, have issued a new catalogue of their patent sectional and removable covering for steam boilers, piping, &c.

Messrs. Drake & Gorham, Ltd., have sent us a small booklet containing a description of the works of the Jandus Arc Lamp and Electric Co., at Hartham Road, Holloway. An account of these works and their equipment recently appeared in the Electrical Review.

A price list of regulators and motor-starting rheostats, got up in their usual style with thumb index to sections, has been published by the Electrical Co, Ltd. It is fully illustrated with diagrammatic and other illustrations.

The Berliner Telephone Manufacturing Co., of Queen Victoria Street, E.C., has issued a fifth edition of its catalogue of telephones and accessories. A special effort has been made to make the book as comprehensive as possible and diagrams of connections appear of nearly every telephone included. We cannot, of course, attempt to detail here all the numerous items, but they cover pretty well all requirements in telephonic apparatus. The illustrations are plentiful and well executed, and the general appearance and get-up of the publication make it more attractive than is sometimes the case with trade catalogues. The list will be of interest to all who are connected with the telephone business, and we may mention that a complete stock of loose sheets of the various illustrations and diagrams is kept for the use of any who apply for them.

Messrs. Siemens Bros. & Co., Ltd., have just brought out a pamphlet entitled "Electric Crane and Capstan Equipment." The construction of the "C" type motor is explained, and its suitability for this class of work referred to, controllers, switches, resistances, brakes, connection boxes and other parts of a crane installation being also described. There are numerous excellent illustrations, and tables of dimensions appear at the end of the pamphlet.

Messrs. Hayward, Tyler & Co. have placed before us a copy of their new "M" catalogue in which are described a variety of types of electrically-driven and other treble-barrel pumps. A brief description and a small and neat picture is given of each item in the list.

Two new lists have been brought out by Messrs. Johnson and Phillips, one (S G) dealing with electric light shades and glassware, and the other (L A) being devoted to electric lighting accessories.

Trade Announcements.—Messrs. R. W. Blackwell and Co., Ltd., announce the following changes in address of their branches:—Paris office, from 50, Boulevard Haussmann, to 20, Rue St. Georges, Paris; Paris Stores, from 83, Rue Phillippe, Girard, to 40, Quai Michelet, Levallois-Perret, Paris. The company having taken over the works lately occupied by the Dunlop Tire Co., the Brussels office and stores have been removed from 1, Rue d'Arenberg, to the company's new building at 20, Avenue de Boulevard, Bruxelles-Nord.

Mr. Ernest W. Dunton, chief electrical engineer at Earl's Court, London, has been appointed as engineer and manager to the Southern Electrical Installation and Wiring Co., of Hastings.

The Gilbert Arc Lamp Co., Ltd. of Chingford, has appointed Mr. David Alexander, A.M.I.E.E., of 79, West Regent Street, Glasgow, as its sole agent for Scotland and Ulster, and all inquiries for Gilbert arc lamps and specialities in those districts should be addressed to him.

The Allgemeine Electric Co., hitherto established at 25, Victoria Street, Westminster, having been amalgamated with the Electrical Co., Ltd., the latter company has decided to retain those offices for its central supply station department. All inquiries respecting power and lighting plant, dynamos and motors, wire and cable, arc lamps, Nernst lamps, incandescent lamps, fittings, &c., should, however, be directed to the head offices, 122 and 124, Charing Cross Road, W.C., as heretofore.

Mr. Henry Adams, M.I.C.E., M.I.M.E., consulting engineer and surveyor, writing from 60, Queen Victoria Street, E.C., says:—"The paragraph in your issue of 21st ult., referring to the dissolution of partnership between Mr. Williams and myself, would lead one to suppose that I have given up business. This is not the case, as I am still continuing my practice as a consulting engineer in the same rooms that I have occupied for the last 23 years."

For some years past Messrs. Carson & Evans, of 42, Finsbury Square, E.C., have done a large trade in general rubber goods, and a few years ago they added a branch for the supply of ebonite and vulcanite for electrical purposes. The firm is making a speciality of accumulator boxes, switchboards, switch handles and keys (solid or covered), insulators, bushes, bobbins, valves, washers, discs, plain and perforated sheet, rod, tubing, telephone fittings, and any special moulded or turned articles in ebonite to pattern supplied.

Dissolutions and Liquidations.—Worcester Tramways, Ltd., on October 31st, resolved to wind up voluntarily (Mr. John Raworth, chairman).

The Westralian Electric Lighting and Supply Co. meets at Lennox House, W.C., on December 30th, to hear an account of the winding-up from Mr. G. Saies (liquidator).

The General Tramways Construction Syndicate will have an account of the winding-up laid before it on December 29th at 43, Threadneedle Street, E.C.

First meetings of creditors and contributories of the Electric Railways Co. are to be held to-day at Winchester House, E.C.

The Buenos Ayres Electric Tramways Co. is winding-up voluntarily, with Mr. E. G. Summers, St. George's House, Eastcheap, E.C., as liquidator.

December 31st is the last day for receiving proofs for intended dividend in *re* Electric Lamp Regenerating Co., Ltd.

Messrs. A. H. M. Francis & R. S. J. Spilsbury (Francis & Spilsbury, electrical engineers, 20, Bucklersbury, E.C.), will dissolve partnership as from December 31st next. After that date all debts will be attended to by Mr. Francis, who will continue the business under the style of Francis & Co.

War Funds.—The employés of Messrs. Crompton and Co., Ltd., have now closed their subscriptions to the Soldiers and Sailors Wives and Families Reservists' Fund. We are informed that when the war started it was resolved "that subscriptions to this fund should be voluntary, and that 1d. per week should be deducted from each man's wages." The subscription list as now closed, shows that the total amount subscribed was £583 5s. 9d.

Premier Lamps.—The Premier Electric Lamp Co. has secured big contracts from the Lancashire and Yorkshire Railway and from the Midland Railway for the supply of incandescent lamps for the year 1903.

Book Received.—"The Viâ Eastern Telegraph Social Code," compiled by R. T. Atkinson. London: Wm. Hutchinson and Co. and R. T. Atkinson, Salisbury House. 1902. 5s. net.

ELECTRIC LIGHT AND POWER NOTES.

Baltimore.—A syndicate has purchased interest to the amount of two million dollars in the Baltimore electric power companies, and has formulated a scheme to provide Baltimore with electricity to work street tramways, public lighting, &c., the scheme to take two years in carrying out.

Birmingham.—An explosion took place in Colmore Row last week through the fusing of an electric cable in a junction box near the corner of Newhall Street. The heavy cover of the junction box, a slab of concrete in an iron frame, was hurled into the air, but fortunately those who were in the vicinity were not injured. The fusion of the main caused a momentary interruption in the electric lighting of the neighbourhood. This seems to be the first incident of the kind in Birmingham. The Corporation experts have failed to discover any escape from the gas mains, and are unable to account for the explosion.

Blockley.—In order to take advantage of the electric light installation provided by Messrs. Spencer & Co., of Stratford-on-Avon, the Parish Council has adopted the Lighting Act. With 36 street lamps the annual cost will be £75 17s. 3½d.

Bradford.—On Friday, the 14th ult., the first large 2,000-H.P. engine and generator installed at the new Corporation electricity station in Valley Road was put on to the circuit for the supply of the electric tramways. For the first few days the load on the engine was kept comparatively light, in order to make sure that the working was satisfactory. On Monday, the 17th ult., full load was put on the engine for the first time, and the full tramway service was resumed, and has since been maintained. The engine has been running for six hours each day since this date, and has proved itself to be thoroughly reliable and satisfactory. The contractors for the engine, Messrs. Cole, Marchent & Morley, Ltd., of Bradford, are to be congratulated upon the expeditious way in which they have carried out the erection, and the same must apply to the British Westinghouse Electric and Manufacturing Co., Ltd., of London and Manchester, who were responsible for the erection of the generator. Owing to the very short time at their disposal, the work has had to be pushed on with the utmost despatch, and it is highly satisfactory to find that in spite of this high pressure of work, not the slightest hitch has occurred in starting the engine and getting it on to the load. It was only in the Spring of this year

that it was possible to commence building operations on the new station in earnest, and in the nine months that have elapsed since then, the large engine house and boiler house have been completed, and 4,000 H.P. of plant, comprising boilers, economisers, engines and dynamos, with the numerous accessories that go to make up an electric lighting station, has been installed. The carrying out of this work, in the way in which it has been done, reflects the greatest credit upon the staff of the Corporation electricity department, and Mr R. A. Chattock, the city electrical engineer, is to be congratulated upon a performance that has been rarely equalled in the history of electric lighting undertakings. Mr. W. Jones, the superintendent engineer at the works, and Mr. N. A. Atkinson, the clerk of works, must also be mentioned as having contributed very materially to the success that has attended the carrying out of the work. The late chairmen and deputy-chairmen of the E.L. Committee, Messrs. Shaw, Moorhouse, Croft and Akam, and the existing chairman, Mr. Councillor C. E. Dowson, and deputy-chairman, Mr. Alderman J. Hustler, took a close personal interest in the work, and gave great assistance in its execution.

Brazil.—The Brazilian Government has recently issued a regulation requiring all vessels navigating the River Amazon to be provided with electric light projectors in order to avoid collisions. It is stated that this decision affects 500 steamers.

Brighton.—The work of laying the foundations for the new electricity works at Portslade is now completed, and the contractors for the steel superstructure have taken the place in hand. Very considerable difficulties have been encountered, and the work has cost nearly £50,000, which is very greatly in excess of the estimates. The present site used to be the old entrance to Shoreham Harbour, and consequently the foundations had to be taken down a great deal deeper than was at first anticipated, as the ground was chiefly made up of sea beach and mud. However, the chief difficulties now having been overcome, it should not be long before the building begins to take shape. When finished it will undoubtedly be one of the finest stations in the South of England.

Cheshire Power Scheme.—A scheme is in course of preparation for the incorporation of a company for the manufacture of gas for power purposes, and electricity for power and for sale in bulk for lighting purposes. The area to be covered by the company's operations is to comprise the whole of the county of Chester, as much of the county of Derby as lies north-west of Chapel-en-le-Frith and Bakewell; the county of Stafford north of, and including, Tutbury, Uttoxeter, Stafford and Gnosall; as much of Flintshire as comprises Buckley, Connah's Quay, Mold, Holywell, and Hawarden; and as much of the county of Denbigh as comprises the borough and district of Wrexham. The manufacture of gas and the generating of electricity are to be carried on at stations to be erected at Sutton, near Runcorn; at Stone, in Staffordshire; at Bollington, in Cheshire; and at Acrefair, near Wrexham. The water required for condensing purposes is to be drawn from the Macclesfield Canal. The title of the company is to be the North-Western Electricity and Power-Gas Co.

Croydon.—In his report to the C.C. on the fire at the electricity works, the electrical engineer, Mr. J. Gray-Scott, states that it began in the test room, but was instantly followed by a second fire in an underground chamber below the switchboard; the former was readily extinguished, but the latter, which involved the mains from the switchboard to the generators and the feeders, could not be overcome until the station was shut down. Notable courage was shown by Mr. Thompson, the senior shift engineer-in-charge, in entering the chamber and endeavouring to extinguish the flames at the risk of his life, and the other members of the staff are highly commended for their zeal in re-establishing the supply. The actual cause of the fire is not known.

Derby.—The T.C. has authorised the Tramways Committee to engage the services of an expert, to report upon various sites for the proposed station for the generation of electrical energy.

Dundee.—The proprietors of the *People's Journal* have introduced into their establishment a four-roll printing machine, which is driven by electric power, each half being connected to a 25-H.P. motor, supplied by Messrs. J. H. Holmes & Co. The installation is on the well-known Holmes-Clatworthy system. Power is taken from the town mains.

Eastbourne.—Mr. W. C. C. Hawtayne, the consulting engineer, has reported that the rubber-covered cables which were at one time used largely by the late company have gradually given out, and that the somewhat frequent breakdowns have all occurred on these old cables, which are laid in practically all the main thoroughfares. No fewer than 11,600 yards of new cable will be required to replace that which is practically worn out, at a cost of £7,500. The E.L. Committee has adopted the engineer's advice, and recommends the Council to proceed with the work.

Eccles.—The T.C. on November 26th decided to erect 100 Nernst electric lamps in the borough in order to improve the street lighting.

The borough electrical engineer, Mr. Angus, has been instructed to report fully upon his scheme for increasing the demand for electricity, including the adoption of a system of prepayment meters.

Felling.—On Monday the U.D.C. decided to accept the offer of Messrs. Handcock & Dykes, electrical engineers, to advise the Council upon electrical matters.

France.—The Southern Railway of France possesses near its station at Bordeaux extensive shops, which give employment to about 1,000 workpeople. Until a short time back, says the *Revue Générale des Chemins de Fer*, steam and gas engines varying in size from 1 to 100 H.P. had been used to drive the machine tools, which number 100, but the management has just installed an electric plant, being convinced that electricity would prove more economical both for lighting and power. The entire installation was entrusted to the Société Alsacienne de Constructions Mécaniques, of Belfort. The power-house equipment comprises at present three generating sets, each of 500-H.P. capacity, but sufficient space has been left for a fourth set. Each set consists of a Corliss engine coupled to a direct-current shunt-wound generator having an output of 1,400 amperes at 240 volts. The drum-wound armature is keyed direct on to the engine shaft. There are two balancing sets, one of which is kept in reserve. A nine-panel switchboard distributes the current to eight main circuits. The motors are arranged within a radius of 500 yds. from the power house, with the exception of two of 15 H.P. each, which are situated nearly three-quarters of a mile away and are used to operate pumps. The lighting load amounts to 250 arc lamps and 2,700 incandescents. There are 46 motors installed, aggregating 775 H.P.; the sizes vary from 1 to 60 H.P. Two 45-ft. turntables are operated by motors; the current is led by underground cables to two concentric insulated copper rings clamped to the centre support of the table. From these rings the current is taken off by two brushes and conducted by lead-covered cables to the motor, which revolves with the table. A switch placed near the motor, with a rheostat, allows the turntable to revolve in either direction. A 15-H.P. motor operates a capstan which is used to haul cars filled with ashes up an inclined plane, from which their contents are shot into trucks.

Germany.—It is proposed to establish a central power station at Gravenstein, Schleswig, for the supply of electricity for electric lighting and power purposes in the Sunderoitt peninsula.

The gas company at Hirschberg, Silesia, has decided to establish a central electric lighting station in the town.

Gorton.—The U.D.C. has decided to take the necessary steps for obtaining the consent of the B. of T. for a two years' extension of time in which to carry out its obligations under its electric lighting order.

Hebden Bridge.—The U.D.C. has discussed an application for sanction to borrow £12,000 for the provision of a generating station. An offer from Halifax Corporation to supply the needs of the district was considered as an alternative, and the matter was referred back to the Committee for further consideration.

Last week new plant at Halifax, and a transforming station at Hebden Bridge, 7½ miles distant, which have entailed a cost of £27,000, were inaugurated. The current is transmitted to the transforming station from Halifax at a pressure of 5,500 volts. The cost has been greatly increased, by comparison with the actual needs of the moment, because of the prospect of supplying Hebden Bridge in bulk.

Hull.—It was reported at the meeting of the Corporation E.L. Committee on November 28th, that owing to the increased demand for electricity, considerable extensions of the plant would be necessary at no distant date. In view of the fact that it was nearly 16 months since the Committee decided to order the last two additional engines, and that those engines were not yet delivered or at work, the electrical engineer advised that one additional engine and dynamo of 800 I.H.P., and two additional boilers should be included in the new plant, as it appeared certain that they would be required by the time they were able to be set to work. An additional economiser was required at the generating works. Finally, Mr. Barnard recommended mechanical stokers and coal elevators for four boilers.

The Committee instructed the engineer to prepare plans and estimates for the suggested extensions and to invite tenders.

It was also decided, in order to encourage the use of power for long hours, to adopt the Leeds Corporation's scale of charges, in which the price was dependent on the number of units used per horse-power per annum, giving a cheaper rate to those works where the motors were used for longer hours, from 2d. to 1d. per unit. Electricity used for cooking or other heating purposes to be charged at 2d. per unit as heretofore. This scale of charges, it was suggested, should not interfere with the special scale for large works. The report was adopted.

India.—The Indian Government has decided to adopt electricity for lighting and punkah-pulling in the military hospitals and cantonments, and has authorised an installation at Fort Attock at the cost of a lakh of rupees.

Keighley.—On November 27th a L.G.B. inquiry was held into the application of the T.C. for a loan of £4,775 for electric lighting purposes. There was only slight opposition, on the ground that the electricity works were not paying. The electrical engineer, Mr. Smith, said that, although the Corporation did not sell anything like the quantity of electricity which would make the works a paying concern, yet the demand had this year increased by 200 per cent.

Fife Power Scheme.—A Bill is to be promoted in the next session of Parliament to constitute a company with powers to supply electrical energy in the County of Fife. The proposals in the Bill involve the establishment of five electrical generating stations at suitable intervals over the county, with distributing mains to all the chief towns, collieries and manufactories. In the Fife area it is estimated that there are over 400 collieries and factories; there are railways and tramways in some of the towns, and others are being promoted or suggested. All these could be supplied with power by the proposed company. At present in the area there is only one town or district where there is power to supply current, namely, Kirkcaldy. Here the supply is in the hands of the Corporation, which will most likely be prepared to supply energy at from 4d to 6d. per unit. It, however, will be catering for an "electric lighting load" and not for the "power load" which the company desires to obtain. By the scheme in the Bill it is expected the electrical energy will be much more cheaply produced, and it is intended to charge from 1d. to 1½d. per unit for power. The promoters seek power to supply in bulk to any Corporation or tramway company or other "authorised" body which should desire to take current from them.

Kent Power Scheme.—The Kent Electric Power Syndicate is very active just now. It has recently purchased the Chatham undertaking of the Chatham and District Electric Lighting Co for a large sum; it has been (and is, in fact, now) running with the Rochester Corporation, and the Chatham and District Light Railways Co., in endeavouring to obtain powers to run electric tramways through Rochester and district, and from Rochester to Gravesend and Maidstone, and recently it gave notice of its intention to apply to the B. of T. for a prov. order to supply electrical energy in the districts of Strood and places between that town and Dartford.

Leek.—On the recommendation of the Electricity Committee, the U.D.C. has decided to apply to the B. of T. for an extension of the prov. order for three years from June 25th, 1902. This is nothing if not cool. Evidently the Leek U.D.C. does not know that the B. of T. cannot extend the order for a single day (though it can bang the order up and say nothing about it for any length of time, but that is another story).

Llangollen.—An electric lighting and power company has been formed to carry into effect an extensive project of installing electric light in Llangollen.

London.—City.—From a circular recently issued by the Charing Cross and Strand Electricity Supply Corporation, Ltd., it appears that the prices charged for electrical energy are 5d. and 2d. per unit for lighting, 3d. and 2d. (or a flat rate of 2½d.) for power. The generating station at Bow will provide for a supply equivalent to over a million 8-c.p. lamps, and storage has already been provided of more than twice the capacity of any other battery plant in the kingdom. There are 18,000 8-c.p. lamps connected to the City mains of this Corporation, and contracts for 40,000 more have been entered into; the supply in the west-end amounts to about 280,000 lamps, so that the importance of the City supply is rapidly becoming comparable with that of the older undertaking. The printing and publishing trades have largely taken up electrical power for driving their machinery, finding it both eminently suitable for this purpose, and inexpensive.

Camberwell.—A motion to purchase the County of London and Brush Provincial E.L. Co's. undertaking in the district was discussed by the members of the Borough Council last week.

A deputation from the Municipal Association presented a resolution unanimously adopted at one of the largest public meetings ever held in Camberwell in condemnation of the proposed purchase. The spokesman said that the ratepayers felt that the Brush Co. was all along aware that electric lighting could not pay in Camberwell, and had undertaken the work, which had been done with feverish haste, in the belief that the undertaking would be purchased by the Borough Council. Gas was cheaper in the district than in any other portion of the kingdom, and it was impossible for electricity to successfully compete with it under the most favourable circumstances.

Another deputation from the Ratepayers' Association also protested against the suggested purchase. The report of the delegates appointed by the Council to consider the question was presented. They made no recommendation.

Councillor Tomkins moved: "That, subject to the site being a satisfactory one and the mains laid found to be in good working order, an offer should be made to purchase the Brush Co's. installation within the confines of the borough, together with all their rights in relation to their Camberwell order, for a sum not exceeding £140,000, such offer to include the land and exclude the machinery at Wandsworth, with a proviso for the company to supply the Council with current in bulk at 1½d. per unit for a period not exceeding three years." The proposal to purchase was opposed on the ground of expense. With the erection of a generating station and the purchase of machinery, it was argued the total capital expenditure would be nearly a quarter of a million. Councillor Tomkins's proposition was negatived by a large majority, only seven voting in its favour.

After discussion, it was unanimously resolved: "That the reference to the delegates be discharged, and that they be thanked for their report."

Subsequently a notice was read from the Brush Co., stating that they proposed to commence the supply of direct current at a declared pressure of 410 volts. A communication was also read from the London Electric Supply Corporation of its intention to apply for powers to supply electricity over a further portion of the borough.

Stepney.—The Borough Council at a meeting on Wednesday last week decided to inform the L.C.C. that it was in favour of a renewed application being made to Parliament for powers authorising the Council of any Metropolitan Borough supplying electrical energy to expend money upon the wiring and fitting of consumers' premises.

Greenwich.—Notices were received at the meeting of Greenwich Borough Council on Wednesday from the Blackheath and Greenwich District Electric Lighting Co., Ltd., of its intention to lay mains along Church Street, Bridge Street and Norman Road, along the south side of Woolwich Road, from Victoria Road to Church Lane, and also along a portion of Anchor and Hope Lane. No opposition was offered.

Southwark.—On Wednesday last week, at the meeting of the Borough Council, notice was received from the London Electric Supply Corporation, Ltd., of its intention to lay high and low pressure distributing mains in Great Charlotte Street, New Cut, Broadwall, Short Street, and to construct underground converter chambers and inspection boxes. No objection was offered to the proposal subject to the work being commenced within three months, and that it be carried out to the satisfaction of the borough engineer. It was reported that 24,642 8-c.p. lamps (equivalent) had been connected with the Borough Council's mains for light, and 2,618 for power.

Peckham.—The M.B.C. has decided to abandon the proposed electric lighting scheme.

Islington.—The M.B.C. has resolved that on and after January 1st the charge for electricity supplied to private consumers shall be either the existing scale, viz., 7d. and 4d. per unit, or a flat rate of 5d. per unit, and that on and after that date all consumers be allowed the free use of meters.

Maidstone.—The Maidstone Gas Co. has engaged an electrical expert to ascertain whether the recent fatal gas explosion on the river bridge was caused by the Corporation electric light cables, which run close to the gas mains. The cable has been cut and tested, and a section sent to the B. of T.

Mansfield.—Rapid progress is being made in the erection of the electricity works, which the Corporation is constructing at a cost of £50,000. It is hoped that the works will be completed by March next. Apart from the public lighting of the town, 55 applications have been received for 3,500 8-c.p. lamps. A refuse destructor and an inclined railway are included in the scheme, the actual capital expenditure on the electricity works proper being £40,000.

Market Drayton.—Last week the formal opening of the generating station of the Market Drayton E.L. and P. Co., Ltd., took place, in the presence of a large number of guests. The work was carried out by Messrs. Edmundson's Electricity Corporation, Ltd., whose managing director, Mr. F. E. Gripper, explained the installation to the visitors. The plant consists of a Davey-Paxman locomotive boiler, and a 45-kw. Bellis-Parker steam dynamo, running at 480—530 volts. A Pritchetts & Gold battery is provided, and the usual accessories; space is left for duplicating the plant. Mr. C. W. Bentley is the resident electrical engineer, and has pressed on the work with all possible speed, besides connecting consumers' installations and erecting public illuminations comprising 600 lamps for the opening ceremony.

Mexico.—The Mexican Government has granted a concession to Messrs. German, Roth & Co. to put down a plant to utilise the water power of the River Verde in the generation of electrical energy.

Newstead (Notts.).—This mining village has now got an installation of the electric light, the colliery company having completed a scheme.

Ormskirk.—The U.D.C. on November 25th decided to dispose of its prov. order for electric lighting to some company which would work it and give the Council the option of repurchase at an agreed price.

Rotherham.—At a meeting of the Board of Guardians, some comparative figures were given as to the cost of electric light *versus* gas at the Rotherham Hospital. Gas:—1901, June quarter, £25 6s.; September, £22 10s. 9d.; total, £47 16s. 9d. Electricity:—1902, June quarter, £21 18s. 1d.; September quarter, £20 13s. 1d.; total, £42 11s. 9d.

St. Helens.—The Electric Supply Committee has instructed the electrical engineer to undertake the wiring of consumers' premises, to wire certain houses free of charge as an experiment, and to charge the consumer 6d. per unit for the energy consumed. The charge ruling under ordinary conditions is 4½d. for lighting and a maximum of 2d. for power.

Swinton and Pendlebury.—The Lancashire Electric Power Co. has offered to supply the U.D.C. with electricity for lighting from its station in Trafford Park by October 1st next.

The U.D.C. has declined the offer of Messrs. Enright & Co., of London, to devise a scheme of electric lighting for the town.

The Salford Corporation has intimated to the U.D.C. that it intends to promote a Bill in Parliament in which it is proposed to empower the U.D.C. to transfer to the Corporation all or some of its powers, or works constructed under the Electric Lighting Order. The U.D.C. has decided to oppose the inclusion in the Bill of any such clause, the Council being determined not to part with its powers to anyone.

Shipley.—The U.D.C. has decided to apply to the L.G.B. for sanction to borrow £45,000 for electric light and power purposes.

The Electricity Committee on November 25th recommended that the salary of the resident electrical engineer (Mr. H. D. Schofield) should be increased from £160 to £200 per annum. Mr Schofield was given an advance of £50 six months ago. The recommendation was referred back to the Committee.

Slough.—Notice of the intended transfer of the U.D.C.'s prov. order to the Slough and Datchet E.S. Co. appeared in the *London Gazette* for November 28th.

Spain.—La Sociedad La Minera Asturiana has applied for a concession to put down a plant to utilise the water-power of the River Nalon at Locoballes, in the generation of electrical energy.

Switzerland.—The recently completed hydro-electric installation of Vouvry, in Switzerland, which utilises the waters of Lake Tanay with a fall of 950 metres, now boasts of the highest existing head of water, being nearly 50 per cent. higher than the Gurtenellen, near Geschuen (at the north entrance of the St Gothard tunnel), or the Chapareillan, which were hitherto considered to possess the highest falls. The Vouvry power station belongs to the Société des Forces Motrices de la Grande Eau, and utilises in the first instance a fall of 200 metres, working with a supply of about 1,250 litres. The electric energy thus produced is distributed in various villages in the Rhône valley. The coupling of the two stations, which possess alternators of the same voltage and periodicity, and capable of being put into action on the same system, will permit of not only greater security, but also a greater total power than the sum of the two worked separately. Allowing the water to flow from Tanay Lake as required in the power station, from 10,000 to 12,000 H.P. can be developed, but the present installation is only of 2,000 H.P., while 2,000 H.P. additional is about to be installed. The turbines were supplied by the Mechanical Constructions Co., of Veney, and by M. Duvillard, of Lausanne. The turbines of the former drive alternators of Messrs. Brown, Boveri and Co., of Baden, and those of M. Duvillard drive alternators furnished by the Electrical Industry Co., of Geneva. All the alternators produce single-phase current at 60 amperes, at a pressure of 5,500 to 6,600 volts at 50 cycles per second. The present installation of 2,000 H.P., including initial expenses—water, rights, &c.—has cost a matter of 800,000 francs, or 400 francs per horse-power. The subsequent 2,000 H.P. to be installed will necessitate the laying of a new conduit and four new electric units, at a total cost of 300,000 francs, which will reduce to 275 francs per horse-power the cost of the first 4,000 H.P. This rate will be further diminished as the station approaches completion.

Totnes.—The Totnes Electricity Supply Co. having asked the B. of T. to defer consideration of the revocation of the E.L. order for a year, the Board replied to the effect that on a deposit of £500 being paid it would be prepared to consider the matter. In answer to this, the company stated that the undertakers were now prepared to put in hand and complete the compulsory works within 12 months, and would forthwith pay the £500. They had made satisfactory arrangements with Messrs. Crompton and Co., who were prepared to aid them financially, and to execute the works if the necessary extension of time were granted. When the matter came before the T.C. on November 26th it was decided to withhold consent to the extension of the order at present. In the meantime a committee is to consider the matter.

Wallasey.—On Tuesday last a L.G.B. inquiry was held with respect to an application of the U.D.C. for power to borrow £52,350 for the purpose of electric lighting and traction. The electrical engineer estimated that, upon the basis of the average increase in the demand for electric light since the installation of electricity, a sum of about £26,000 would be required to meet the demand for the ensuing year. The traffic upon the tramways was increasing very rapidly, and, assuming that 45 additional cars would be required by the Tramways Committee during the next seven years, £26,000 would be ample to provide an efficient plant to generate sufficient energy to properly run 70 cars. The inspector pointed out that within seven years much more economical machinery might be introduced, and they might be burdened by an ancient plant. He wanted them to have everything that was necessary for three years, but he would not advise them to make provision for seven years. We fail to see on what grounds the inspector (Mr. R. H. Bicknell) based his suggestion that within seven years up-to-date plant will have become obsolete.

Weymouth.—A fierce agitation is going on both for and against the Corporation's electricity supply scheme, and a poll of the ratepayers was taken on Monday last.

Wigan.—The R.D.C. has decided to obtain a prov. order empowering it to supply electricity in its districts. The area comprises the parishes of Haigh, Shevington, Wrightington and Parbold.

ELECTRIC TRACTION NOTES.

Altrincham.—At a meeting of members of the Altrincham, Ashton-on-Mersey and Bucklow Councils held recently, the representatives of these bodies unanimously adopted a resolution recommending the three Councils to oppose the Bill to be promoted by the B.E.T. Co., with a view to united action in order to obtain a joint prov. order for the construction of tramways in their respective districts. The Sale Council has decided to accept the B.E.T. Co.'s offer.

Burton-on-Trent.—As an outcome of the order granted to the Midland Railway Co., the T.C. has decided to apply for a prov. order authorising the Corporation to construct electric tramways from the foot of the bridge up Ashby Road to the borough boundary, and from Brentwood Hill, Winshill, up High Bank Road to Ashby Road, so that all the lines in the borough shall be owned by the Corporation. The railway company will lease the lines, and take energy from the Corporation.

Central London Railway.—Delivery of the motor cars to take the place of the electric locomotives will commence in the early part of next year.

Chatham.—The Coroner's inquiry into the Chatham tramway accident was closed on 26th ult. Charles Taylor, a driver in the employ of the Chatham and District Light Railways Co., deposed to discovering flats on the wheels of the car on the day before the accident and reporting the occurrence at the power station. The wheels locked as he was descending Chatham Hill and the car skidded, but he attributed this to his applying the hand brake too hard. In summing up the Coroner pointed out that in the opinion of Major Pringle, the Board of Trade inspector, the fact that more passengers were carried on the car than there was seating accommodation for did not contribute to the accident. The unfortunate mishap seemed to be due to the fact that the driver, in direct contravention of his orders, started down the hill without waiting for the pilot, and perhaps allowed the car to attain too great a speed at the beginning of the downward journey, then lost control, and, either from ignorance or loss of nerve, failed to reverse the current when he found the car was travelling too fast. That he acted negligently in doing this was clear, and he could not be acquitted of blame. The question for the jury to decide was—Was the negligence of so grave a nature as to amount to criminal negligence, or was it only censurable negligence? The jury returned a verdict that the victims came by their death through injuries received from the accidental overturning of the car, and that the accident occurred through the negligence and incapacity of the driver, Frederick Charles Pearce. They added a rider that in their opinion the regulations of the company are not sufficiently enforced with regard to sanding and cleaning the rails, especially on gradients, and also with regard to the conduct of the drivers. They also expressed satisfaction that the company had decided to abandon the route down Westcourt Street, which, in their opinion, was dangerous.

Cheshire Lines.—It is stated that the Cheshire Lines Committee are considering the advisability of going in for the electrification of their lines between Manchester and Liverpool. It is proposed to seek Parliamentary powers.

Glasgow.—The work of erecting the overhead equipment on the Clydebank extension of the Corporation tramways has been stopped on account of delay on the part of the Post Office authorities in altering the position of some of their wires on this route, which cannot be proceeded with until permission is obtained from headquarters.

Gloucester.—The T.C. has unanimously decided to convert the existing horse tramways into light electric railways as soon as practicable. With regard to the question of joint ownership of the line between the T.C. and the C.C., which has been under discussion for a long time, the clerk to the county authority has advised that the terms to be settled between the two bodies should be referred to the Light Railway Commissioners. The T.C., however, whilst willing to confer with the Commissioners upon the matter, are not agreeable to refer the whole question of terms, because they are not prepared to run any risk of loss in the working of a line outside the city, and which would not be their property.

Heckmondwike.—At a meeting of the D.C. on 24th inst. it was reported that the negotiations with the B.E.T. Co. had been completed, and a resolution was unanimously adopted authorising the signing of the necessary agreement.

Hove.—On Monday, December 1st, the T.C. met to finally decide whether to promote a Tramway Bill this session or whether to allow the B.E.T. Co. to come in. After a long controversy it was decided for the Corporation itself to promote the Bill. Among the speakers was Alderman Washington, who spoke against the Corporation scheme. Later, when the meeting voted, he, by mistake, voted for the Corporation, and by his vote only was it decided that the Council should go to Parliament for a Bill of its own. Had he voted as he meant to do there would have been no municipal scheme next session. That the question should have been decided in this fashion is extraordinary. One important announcement was made during the meeting—that the Tramways Committee has entirely abandoned the proposed Western Road lines.

Ilford.—The U.D.C. is applying for a prov. order to enable the tramways to be extended to Hainault Road and Cranbrook Road.

Light Railway Scheme.—The London and South-Western Railway Co. has given notice of an application to the Light Railway Commissioners for an order to authorise the construction of the Totton, Hythe, and Fawley light railway.

Liverpool.—The work of electrifying the Mersey Tunnel Railway is rapidly approaching completion. The contract term expires on January 15th, 1903. The generating station for supplying current for working the new electrical train service has been erected by the side of Shore Road, Birkenhead. The station consists of two buildings, viz., a boiler house and a generator house. The generating house is 145 ft. long, 51 ft. wide, and 68 ft. high. A chimney stack, 250 ft. high, rises from one side of the boiler house. Five Westinghouse generators, three of 1,200 KW., and two of 200 KW., representing, roughly, 6,500 H P., coupled direct to compound Westinghouse engines of marine type, will be employed to produce energy. Steam will be supplied by nine water-tube boilers of the Stirling type. An automatic conveyor will be provided for moving coal from the discharging bank to the boilers. In the Mersey tunnel the track has been relaid, and two additional lines have been laid to serve as conductors. The cables conveying the current from the generating house to the conductors in the tunnel will pass down the ventilating shafts. Considerable alterations have been made in the track outside the tunnel, to adapt to the new plan of working. Fifty-seven new cars for the electrical service are being built by Messrs. G. F. Milnes & Co., of Hadley. Each trailer car will be 60 ft. long, and will be divided into three compartments. In the end compartments the seats will be longitudinally arranged, and will accommodate 22 persons. In the centre compartment the seats will run crosswise, and will accommodate 16 persons. In the motor cars a space equal to 10 seats will be set apart for baggage. The first-class cars will be finished in mahogany and bird's-eye maple, and the other cars in birch and bird's-eye maple, all highly polished. Each compartment will be lighted by a 16-C P. incandescent lamp. The cars will be provided with Westinghouse air brakes. The stations will be lighted by electricity, arc and incandescent lamps being used. At the James Street station a number of alterations have been made with a view to facilitating the movement of passengers, more especially in the working of the lifts. Between the Liverpool Central station (low level) and Hamilton Square station, Birkenhead, a 3 minutes' service of trains will be run from 5 5 a.m. to 11 32 p.m. On Sunday a 3 minutes' service will be worked from 9 5 a.m. to 10.44 p.m. A frequent service will be maintained to the other local stations. The work has been carried out under the superintendence of Mr. J. W. Cowper, of the Westinghouse Co.

The Tramways Committee has directed Mr. A. B. Holmes, M.I.C.E., electrical engineer, and Mr. C. R. Bellamy, manager, to examine any patents which seem suitable for use in the Corporation departments, and to report to the Committee respecting the same.

Manchester.—The electric tram service in the southern districts of the city was inaugurated on Monday last. The routes generally have been readjusted, and cars now run through the city to and from the suburbs, greatly to the relief of the congested central thoroughfares: 150 miles of track are now controlled by the Corporation, and, according to a recent report of the Tramway Committee, "this is connected with a much larger system of tramways aggregating probably some 500 miles of track." Some old horse tramlines on the north and north-eastern sides of Manchester yet remain to be electrified, connecting with the towns of Oldham, Ashton, &c. These will probably be completed by the end of March, 1903.

Moscow.—The Commission of the Don has just approved of a project for the construction of an extensive system of electric tramways in Moscow. It has been decided to ask the authorisation of the Government to raise a loan of 4 million roubles to realise the first portion of the enterprise. The entire undertaking will cost a matter of 40 million roubles, and will take five years to complete.

Newcastle-on-Tyne.—At a meeting of the Tramways Committee on the 27th ult. the question of power at the city station was again considered. It was pointed out that the Committee was face to face with an imperative need for more power, and Mr. Le Rossignol was able, acting upon prior instructions, to lay before the Committee some suggestions as to meeting the demand. He now reported that he could obtain in about four weeks' time an engine to increase the supply of electricity. There was a 1,500 H.P. engine, which had been built for the Bolton Corporation, which they could have in the time named for £10,000. It was a compound vertical engine. He also mentioned other engines which it would be possible to get, but the one which met with most acceptance was a 1,250-H P. engine which had come out of a Government gunboat, which could be had for £4,350. This was a triple-expansion engine, and generally met with favour, ultimately it being decided that the gunboat engine should be hired, if possible, with the option of purchase; the question of purchase was left in the hands of the chairman and the vice-chairman. It is reported that a tender for the construction of a new dynamo has been accepted for £5,993.

Northampton.—At the meeting of the T.C. on Monday the Tramways Committee reported that, during the first year's working by the Corporation of the electric trams, a net profit of £955 7s. 5d. had been made, the gross profit being £2,580 15s. 3d.

Notts and Derbyshire.—Notice has been given to the various local authorities in Notts and Derbyshire by Messrs. Ashwell & Tutin, solicitors, of Nottingham, to the effect that a company intends to promote a Bill in Parliament authorising the construction of no less than 40 lines of electric tramways in the two counties. The scheme provides for tramway communication between Ilkeston, Shipley, Heanor, Codnor Park, Ripley, Alfreton, outh Normanton, Blackwell, Hucknall-under-Huthwaite, Heage, elper, Milford, Duffield, Allestree, Derby, Spondon, Ockbrook, Long Eaton, Beeston, Nottingham, Wollaton, Trowell, Sandiacre, Stapleford, Eastwood, Basford, Carlton, Arnold, Hucknall, Torkard and Alfreton.

Poona.—It has been proposed to have tramways in Poona connecting the principal parts of the city and the cantonment with the railway station. There is some talk of utilising the water-power available in the Bhatgar Lake, some 40 miles away, for generating the electricity. In that case electric lighting would go hand in hand with electric traction.—*Indian Engineering.*

Rochester and Chatham.—The Rochester Corporation, the Kent Electric Power Syndicate and the Chatham and District Light Railways Co., are all seeking to obtain powers to provide a system of electric tramways through the districts named.

Salford and Prestwich.—The new line to Prestwich, connecting with the Salford tramway system, is to be opened to-day (Friday), at least in part. The work is being done under contract by the Salford Corporation.

South Staffs.—The B. of T. has renewed the license for the use of steam on the South Staffordshire Tramways for another six months, pending the completion of the electrical equipment.

Swansea.—Eighteen members of the Council have paid their visit to Paris and seen the sights thereof, including the Dolter surface contact system.

Switzerland.—The electric tramway from Bremgarten to Dietikon, connecting the valley of the Reuss with the tramway system of the Limmat valley, may serve as an example of how this modern method of transport can be utilised to the benefit of a district. To generate the electric current the water-power of the Reuss was available, while the excellence of the road between the towns made it possible for the track to be laid without much labour. Added to this, the railway service of Bremgarten was very unsatisfactory, the town being at the terminus of a branch line. Consequently the local authorities of this enterprising little place decided to build a tramway or light railway connecting Bremgarten with Dietikon, where a good train service was available. The line, 6½ miles in length, was laid along the main road, and consists of a single track of 1 metre gauge. There are three passing stations, where the lines are laid so far apart as to allow two cars to pass each other with about 2 ft. to spare. The greatest curve has a radius of 98 ft. The maximum gradient amounts to as much as 60 per cent. for a distance of 100 yards, but the mean gradient is 31½ per cent. The power station contains two turbine-driven dynamos of 85 H P. each, delivering current at a pressure of 750 volts. They are compound-wound machines of the Oerlikon Co., having an efficiency of 91 per cent. at full load, and 88 per cent. at half-load. The trolley system has been installed, the rails acting, as usual, as return conductors. The line pressure is 700 volts. The rolling stock comprises three motor cars, three passenger trailers, and two closed goods cars. The motor cars and trailers can seat 18 persons, with standing room for 10 more on the platforms. The motor cars are equipped with two 35-H.P. motors, giving a speed of 7 to 8 miles per hour. The total cost of the installation amounted to £37,200.—*Schweizerische Bauzeitung.*

Walsall.—The new tramway lines which have been laid through Bloxwich extending the system as far as the Bell Inn, were inspected last week by a representative of the Board of Trade in presence of members of the Walsall Corporation and officials.

Wirral.—On Monday, at the meeting of the Wirral District Council, Sir John Willox, M.P., and Mr. Gill and Mr. Maple, solicitors, submitted the scheme of the proposed Birkenhead and Chester Tramways Co. The Council's surveyor is to report on the Bill.

TELEGRAPH AND TELEPHONE NOTES.

All-British Cable to India.—In the House of Commons on 2nd inst, Sir C. Dilke asked the First Lord of the Treasury whether the attention of the Government had been directed to the recommendation of the Committee on Cable Communications, presided over by Lord Balfour of Burleigh, in favour of a cable connecting the Cocos and Ceylon, or the Cocos and Singapore, and thus giving an alternative and an all-British line to India; and whether any steps were being taken towards the construction of such a cable. Mr. Balfour, in reply, said that the matter was engaging the attention of the Government at the present time. They were waiting a reply from the Government of India, with whom they had been in communication.

On Thursday Sir Edward Sassoon asked the Postmaster-General, as representing the Secretary of State for the Colonies, whether he will consider the advisability of arranging with the Pacific Cable Board that in the interval before opening the Pacific cable to public traffic, or at any other early and convenient date, the consulting engineers to the Board should conduct a series of speed trials over the Vancouver to Fanning Island cable to ascertain, in the interest of scientific knowledge, how many letters per minute this cable is capable of carrying under the simplex and duplex conditions of working, and under either or both of these conditions when an automatic curb is employed; and whether a report of such trials, together with the final tests after the laying of this cable, can be made public.

Australasian Telegrams.—The Direct United States Cable Co., Ltd., notifies the opening on Monday next of a new all-British telegraph route, "*via* direct cable," to Australia, and New Zealand, &c., at a tariff of 3s. per word, by way of Canada and the cables of the new Pacific system.

Cardiff.—Last week the Town Hall Committee considered a report with reference to the telephone communication at the new buildings in Cathays Park. The electrical engineer (Mr. Ellis) said the National Telephone Co. wanted approximately £110 per year for supplying departmental and inter-departmental communication, which, capitalised, would mean about £2,000, and, in his opinion, the installation would not cost more than half that sum if done by the Corporation. It was resolved that tenders should be invited for the installation of the departmental and inter-departmental system of telephones.

Civil Responsibility of Telegraphists.—It is reported that the Berlin Courts have pronounced a condemnation against two telegraphists for having transmitted in a Stock Exchange telegram the word *Kaufen* (to buy) in place of *Verkaufen* (to sell), which caused grave financial trouble to the sender and receiver. This decision is based on the new civil code of Germany, which holds all employés pecuniarily responsible for the errors committed during their service. Those readers acquainted with the "Morse" code, will readily understand how such an error could arise. The two culprits have lodged an appeal, in which they urge that the senders did not avail themselves of the power of having their telegram repeated and compared, which is the stipulated means of preventing error, and which would have led to its detection in this case. The High Courts have not yet pronounced final judgment. The *Riforma*, a telegraphic review published in Madrid, in commenting on this case, makes the following excellent points:—"Our opinion," says our Spanish contemporary "of this charge is that errors committed in the transmission of telegrams are caused by the bad state of the lines, defects in the apparatus, the bad and unintelligible handwriting of senders and operators, the speed at which telegraph work has to be performed, and not by the ill-will of the telegraphist. Thus, the deficiencies of the employé, or his inattention cannot constitute a motive of penal responsibility, because the circumstances exclude intention, which is the sole basis for responsibility. The regulations allow senders to have their telegrams repeated and compared, and furnish a means of preventing errors involuntarily committed in transmission; if this means is not employed they run the risk of getting their telegrams altered by the above-mentioned causes and cannot attribute to the telegraphist other responsibility than that of having committed a fault independent of his will. If such a criterion of responsibility as that of rendering a telegraphist pecuniarily liable for mistakes in telegrams be established, it will create a condition in which the salaries of telegraphists will be insufficient in view of the risks of the profession. *Errare humanum est*, and if such a position were arrived at its logical outcome would be to hold the doctor responsible for errors in his diagnosis should his patient die, and the lawyer if his clients lose their case! The errors in telegraph transmission cannot be prevented by coercive measures, but by forethought and provision. Good lines, good apparatus, well remunerated and normal work arranged in such a way that the staff take a keen personal interest in the service; these are the means of establishing the best and most perfect telegraphic service."

Italian Progress in Telegraphy and Telephony.—In order to improve the connection of the Continent with Sardinia, the iron-wire from Rome to Orbetello has been replaced by a 3 mm. wire of phosphorised copper. On September 29 h a new cable was laid between Puntanera and Spiaggia Grande, to secure telegraphic communication between Sardinia and the Island of Carloforte. On November 1st the new telephone line between Milan and Switzerland commenced its working. The Rome to Paris line is ready, the only questions to be settled are the connections of the call-boxes with the Central Office in Rome and the tariff.

Minister Galimberti has nominated three representatives for the Conference on wireless telegraphy, among whom is Comm. Cardarelli, Head of the Italian Telegraphs, who will shortly proceed to Berlin. Comm. Cardarelli is well-known to many English Telegraph officials in consequence of his sojourn here some years ago.

Municipal Telephony.—The Scarborough Corporation Telephone Committee on November 25th accepted the draft of the license of the Postmaster-General for the establishment of a municipal telephone system.

Portsmouth Telephones.—The National Telephone Co. announces a cheap service with unlimited calls, for £4 17s. 6d. per annum. "At first sight (says a local paper) this looks like the commencement of a telephone war similar to that now in progress at Tunbridge Wells, as the Corporation's annual charge for an unlimited service is £5 17s. 6d. On making inquiries we learn that the rate is for the 'party line' system which was introduced into Portsmouth some 18 months or so ago. The rate for a 'party line' has hitherto been £6 per annum." The system is based upon co-operation between subscribers to the number of two or more, who agree to have all their telephones placed upon the same line. By this means capital charges are materially reduced, and the company are enabled to give the service at the reduced charge, as compared with the £10 per annum charge for an entirely private line. Mr. Bennett, the consulting engineer, engaged by the Portsmouth Corporation, has made a report to the Committee, following upon another inspection of the municipal exchange. He states that work is proceeding satisfactorily, and that notwithstanding that the amount sanctioned by the L.G.B. was £1,100 less than he estimated, it will be sufficient to establish the municipal system in Portsmouth. All underground work in connection with the exchange has been practically completed, and the exchange at the Town Hall is also in working order. When Mr. Bennett reported, about 140 subscribers were joined up and speaking, and it was hoped that between 40 and 50 would be put on each week until the whole of the 1,150 are joined up.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	..
Communication with Carthagena and Barranquilla (Columbia)	Dec. 8, 1900	..
Trinidad-Demerara No. 1	Aug. 27, 1901	..
Trinidad-Demerara No. 2	Nov. 1, 1902	December 1
Dominica-Martinique	May 8, 1902	..
Dominica-Guadeloupe	Nov. 4, 1902	..
St. Lucia-Martinique	May 8, 1902	..
Guadeloupe-Martinique	May 9, 1902	..
Santa Cruz de Teneriffe to Tejita de Teneriffe	July 4, 1902	..
Puerto Plata-Martinique	July 10, 1902	..
Guantanamo-Mole St. Nicholas	Aug. 4, 1902	..
Cayenne-Pinheiro	Aug. 13, 1902	..
St. Lucia-St. Vincent	Sept. 19, 1902	..
Reisai-Issa	Oct. 22, 1902	..
Reisai-Yemani	Oct. 22, 1902	..
Cadiz-Teneriffe	Nov. 3, 1902	..
Zanzibar-Mombassa	Nov. 25, 1902	..
Svebondo-Bandjermasin	Nov. 25, 1902	..
Landlines:—		
Route *via* Hanekin on Persian territory	Feb. 24, 1900	..
Communication with Tientsin and Taku *via* Helampo	July 18, 1900	..
Communication with Maranham	Sept. 19, 1902	..
Majunga-Tananarive	Nov. 30, 1902	..

Tunbridge Wells Telephones.—The *Times* says that in the election for the largest ward at Tunbridge Wells on Saturday, Mr. Nicholson, the late chairman of the Telephone Committee, stood as an avowed opponent of the sale of the Corporation telephones, and was opposed by Mr. Walter Harris. The result was: Harris, 589; Nicholson, 375.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barrow.—January 5th. Two 250-kw. steam generators, switchboards and piping. See "Official Notices" to-day.

Bradford.—December 13th. Electric lighting for the new central baths and public hall. Specifications (£1 1s.) from the City Architect.

Brighton.—December 23rd. Tramway tracks, bonding, and wood paving. See "Official Notices" November 28th.

Bristol.—December 8th. 380 5-amp. d.c. open type arc lamps. See "Official Notices" November 28th.

Bristol.—December 11th. Water-tube boilers and accessories. See "Official Notices" November 21st.

Buluwayo.—February 26th, 1903. Establishment and working of an electric tramway. See "Official Notices" Nov. 21st.

Cardiff.—Tenders for tools for use at the Council's main car depôt. Specification from Mr. Arthur Ellis, electrical engineer, Cardiff.

Chloride Electrical Storage Co.—Lead ashes and peroxide; zinc chloride, ashes and residue. See "Official Notices" to-day.

Clacton.—December 22nd. Two Economic boilers, piping; two 100-kw. steam dynamos, balancer and boosters; switchboard; cables, &c.; accumulators; crane. See "Official Notices" November 14th.

Devonport.—December 29th. Overhead equipment for Corporation tramways. See "Official Notices" to-day.

Dewsbury.—December 11th. Two steam dynamos (200 and 300 kw.) See "Official Notices" November 28th.

Dublin.—December 8th. The D.U.T. Co. wants tenders for general stores, including electrical supplies, for a year. See "Official Notices" November 21st.

Durham.—December 8th. Trimdon Grange Colliery Co. invites tenders for 12 months' supply of various stores including electric light fittings. Forms of tender from the Storekeeper.

France.—January 1st. The Prefectural authorities of the department of Calvados are inviting projects until January 1st, 1903, for the construction and working of an electric tramway, for the transport of passengers and goods between Trouville and Honfleur, a distance of about 10 miles. Particulars may be obtained from, and proposals are to be sent to, La Prefecture de Calvados, Caen.

Harrogate.—December 6th. 4-KW. d.c. dynamo complete and switchboard. See "Official Notices" November 21st.

Hebden Bridge.—December 22nd. Gas engines, dynamos, booster and balancers, battery, switchboard, crane and cables. See "Official Notices" to-day.

L.C.C.—December 11th. Wiring and fittings for electric light and bell installations. See "Official Notices" November 28th.

Luton.—December 15th. Distributing mains. See "Official Notices" to-day.

Mullingar.—December 9th. Repair and renewal of battery. See "Official Notices" November 28th.

N.-E. Ry.—December 8th. Telegraph apparatus and stores (six months' supply). Mr. C. H. Ellison, Telegraph Department, York. Also stores including carbons, wires and cables &c. E. H. Clark, Stores, Gateshead.

St. Pancras.—December 9th. Covered testing truck. See "Official Notices" November 28th.

Salford.—December 6th. Single pilot wire. See "Official Notices" November 28th.

Sunderland.—January 2nd. Lancashire boiler, with fittings, &c. See "Official Notices" to-day.

Swansea.—The Graigola Merthyr Co., Ltd., is inviting tenders for the supply of electrical goods and fittings. Particulars from the company's offices, Cambrian Place, Swansea.

Sydney, N.S.W.—December 17th. Cables, joint boxes, &c. See "Official Notices" November 28th.

Wallasey.—January 15th. Steam dynamo, Lancashire boiler, condensing plant and cooling tower. See "Official Notices" to-day.

CLOSED.

Admiralty.—The tender of the Sir Hiram Maxim Electrical and Engineering Co., Ltd., has been accepted by the Admiralty for a supply of "Maxim" incandescent electric lamps, and we understand that amongst the firms they have recently supplied with large quantities of lamps, are Messrs. Edmundson's for central stations, and Messrs. Dick, Kerr & Co. for traction work. "Maxim" lamps have also been supplied to the House of Commons, and some time since some 300-volt lamps were made for the Royal Arsenal, Woolwich, which are said to have given every satisfaction.

Barrow-in-Furness.—The tender of Messrs. D. Bruce Peebles & Co. has been accepted by the Barrow-in-Furness Corporation for reversible lighting booster and reversible traction booster for their electricity station, the price being £1,090 10s.

Bristol.—Messrs. C. A. Parsons & Co. have secured the order from the Corporation of Bristol for Avonbank Electricity Works, for two direct coupled single-phase steam turbo-alternators, each having a normal output capacity of 750 KW. at 2,200 volts, and an emergency output of not less than 950 KW. at 2,200 volts for three hours. Messrs. Parsons have also secured the order from the Corporation of Portsmouth for two 500-KW. turbo-alternators, with surface condensers and pumps.

Bristol.—The Corporation Electrical Committee on Friday accepted the tender of Messrs. Siemens Bros. & Co., Ltd., for cables, and that of Messrs. Bumstead & Chandler, for induced draught plant for the second instalment of the plant at the Avonbank Station.

Newcastle-on-Tyne.—The T.C. on Friday accepted the tender of British Western Co. for a new dynamo for the electricity works at £5,993.

The Tramways Committee has accepted the tender of Mr. W. Worley for the erection of new car sheds on the West Turnpike.

Reading.—Messrs. R. W. Blackwell & Co., as contractors for the electrical overhead equipment for the Corporation tramways, have accepted the tender of Messrs Rowland Carr & Co. for the supply of the whole of the cast-iron bases, collars, finials and pole guards required.

Willesden.—The D.C. has decided to accept the tender of the Reason Manufacturing Co. for the supply of combined electrolytic meters and demand indicators for £3 10s. or £4 each according to capacity, the number of the order to be limited in the present instance to 250.

FORTHCOMING EVENTS.

Friday, December 5th.—At 8 p.m. Institution of Junior Engineers, Westminster Palace Hotel. Paper by W. J. Tennant, on "The Planimeter, explained simply, without Mathematics."

Saturday, December 6th.—At 2 p.m. Institution of Electrical Engineers (Students' Section). Visit to the generating station of the Central London Railway.

Monday, December 8th.—At 8 p.m. Society of Arts. Cantor Lecture III., by Prof. Vivian B. Lewes, on "The Future of Coal-Gas and Allied Illuminants."

Tuesday, December 9th.—At 8 p.m. Institution of Electrical Engineers (Glasgow Section).

At 8 p.m. Institution of Civil Engineers. Paper to be further discussed—"High-Speed Electrical Generating Plant," by T. H. Minshall.

Wednesday, December 10th.—At 7.30 p.m. Institution of Electrical Engineers (Birmingham Section). The University.

Cold Storage and Ice Association (at the Institution of Mechanical Engineers, Storey's Gate). Discussion on "Municipal Trading."

At 8 p.m. Institution of Electrical Engineers (Birmingham Local Section). Meeting in the University. Address by Mr. Henry Lea on "Recent Progress in Electrical Engineering in Great Britain."

Thursday, December 11th.—At 8 p.m. Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers. Paper on "The Photometry of Electric Lamps," by Dr. J. A. Fleming, F.R.S.

Wednesday, December 17th.—Institution of Electrical Engineers. Annual dinner in the Grand Hall of the Hotel Cecil.

NOTES.

Proposed U.S. Electrical Laboratory.—Our Niagara Falls correspondent writes as follows:—"At the last session of the Legislature of New York State a Commission was appointed to consider the question of the advisability of the State establishing an electrical laboratory. This commission consists of State Engineer Edward A. Bond, Charles P. Steinmetz, of the General Electric Co., and H. W. Buck, electrical director of the Niagara Falls Power Co. The Commission has held several sessions since it was formed, and on November 13th it held one of its final sessions in Niagara Falls. It is understood that the Commission will report in favour of the establishment of a laboratory by the State, also in favour of a standardisation bureau. Among other interesting facts brought out by the commission is that the capitalisation of the companies in New York State, involving the use of electricity, amounts to $1,462,615,595, while the capitalisation of companies engaged in the manufacture of electrical apparatus is $217,974,695, making a total of the capital interested $1,680,590,290. In these figures is represented the capital interested in the use of electricity in the Empire State alone. Considering the manner in which electricity is growing in popular use and application throughout the world, it is no wonder that other States and countries will watch with a vast amount of interest these important steps about to be taken by New York State—a State that is the happy possessor of the greatest electric power development and source of supply. The location of the proposed electrical laboratory will, no doubt be a question for future decision, but Niagara Falls is quite hopeful that it will be located there. In fact, the claim is advanced that there is every reason why it should be located at Niagara, where a large amount of power, at any voltage, would always be on tap for experimental purposes. For this reason, and considering the object of the proposed laboratory, it would appear that no other place could be a rival of Niagara. It is understood that, should the laboratory be established, it would act as arbitrator in disputes over electrical matters, while it would serve as a standardisation bureau, the benefits of which would be manifold to all parts of the State. Every city and town and every individual consumer of electric light would be in place to be benefited. The inaccuracy of meters on the quantity of current supplied to individuals would come up for treatment and remedy. Owing to a lack of standardisation, many cities get good public lighting and others get very bad. When a standard is adopted by the State authorities all should fare alike, and there should be an improved betterment of the illumination in many places. There would be no end of work for the laboratory officials. To-day there are many disputes arising from mutual induction, especially between circuits carrying large currents and the circuits used for the transmission of intelligence, notably the telegraph and telephone lines. Another point is the crossing of circuits and failures of insulation resulting in accidents to life. The subject of electrolysis has long

been a question of consideration in many municipalities, and in all of these places the electrolysis of underground pipes is a feature of alarm. In the systems of insulation and installation the insurance companies in all sections are vitally interested. Then the new department would have the settlement of all disputes between manufacturers and buyers as to the efficiency of apparatus, and in this way a high standard would be established. The question of transmitting power at high voltages through thickly-populated sections would, no doubt, have consideration, especially when the transmission is made by pole lines. The transmission of voltage on overhead lines often causes trouble between the electrical companies and municipalities. It is also probable that the laboratory would have to do with disputes between manufacturers of electrochemical products and the general public, especially where and when poisonous gases or noxious gases are liberated during the process of manufacture, damaging surrounding property and causing much injury to the general health of a locality. As Niagara Falls advances as an electro-chemical centre, such a laboratory would be a great benefit to it. Under the conditions of to-day large sums of money are expended in the adjustment of disputes that might easily and satisfactorily be settled by laboratory officials, removing a heavy burden from both sides of a contest. In case a standardisation bureau were established the official authority from it would supersede the expert witnesses. At present, strange to say, the electrical standards come largely from Germany, and these are not always adaptable to the conditions in the United States. One of the most important features of the proposed laboratory would be to have several thousand horse-power always available, as stated, and phenomena could be observed as well as valuable experiments made. As the equipment of the laboratory world be thoroughly complete, it might be expected that the standard reached would be as high as any in the world. Considering the industrial prominence of New York State, the action of the next Legislature on this question will be awaited with much general interest, while it may be expected that the complete report of the Commission above mentioned will have much in it of interest to the electrical industry."

Scotch and German Steel.—The question of exclusive dealing appears to crop up both in the unions of the employed and the federations of the employers. Whenever found it is bad in principle. Messrs. Denny & Co., the Dumbarton shipbuilders, write to a Glasgow paper that some time ago they purchased some plates from a Scotch firm of merchants, specifying Scotch brands, and the order was placed with a firm outside the combination of Scotch steelmakers; but four of the plates were bigger than could be rolled by an outside firm, and were ordered from Germany, and Messrs. Denny very properly refused them when they discovered the fact, and they asked one of the Scotch combination firms to roll them these four plates. The firm declined, unless Messrs. Denny would reject the whole of the plates supplied by the outside mills, in addition to rejecting the German plates. This meant the scrapping of 110 tons of good and suitable Scotch plates and a loss of £500 to the makers, who offered to bear this loss rather than Messrs. Denny should be inconvenienced. Messrs. Denny would not allow them to make this sacrifice, and appealed to the combination firms not to force them to go to Germany for plates, a thing Messrs. Denny had never yet done; but the combination would not listen to reason, for they were determined to force all the outside firms into the association ring—a piece of tyranny which out-Herods all the follies in this direction of the trades unions. Thus Messrs. Denny have probably been compelled to go to Germany for plates they would prefer to buy at home. Not without cause did Mr. Crosland produce his book, the "Unspeakable Scot," if these be the methods of the supposed educated Scot. Messrs. Denny, having put their pen to paper, go on to point out that the combination are supplying boiler plates for abroad at £1 per ton less than they charge home firms, a bit of American evil dealing which all must condemn as un-English. Messrs. Denny vouch for the truth of this. Here an association of steel makers deliberately set themselves to a given evil course of action, and in the doing of it have no more sense than to compel a firm like Denny & Co. to buy German plates. It is not as though Denny's were known to go abroad for stuff. They have hitherto refused to do so. The law of conspiracy should surely be as applicable to these Scotch plate rollers as to the humbler striker who coerces his fellow labourer by unlawful persuadings, be they bricks or bludgeons.

The Accumulator Industry in Germany and Industrial "Kartells."—Dr. Franz Peters has recently been discussing in the *Centralblatt für Accumulatoren und Elementenkunde*, of which paper he is editor, the financial position of the accumulator industry in Germany. This industry has suffered in common with the other branches of the electrical engineering industry in Germany from over-capitalisation and over-production, and in addition to these evils there have been the further losses incurred by the failure of portable accumulators for tramway and similar purposes. Dr. Peters admits that the portable accumulator industry is practically dead. As regards the manufacture of stationary accumulators, he notes that all the leading firms are tending towards the production of a common type of cell, marked by extreme simplicity and low cost of manufacture. The thousand-and-one patents which have been taken out in this industry, have therefore not proved of much value, excepting for the purpose of capital inflation. Success in the accumulator manufacturing industry to-day is more a question of cheap purchase of the necessary raw materials—lead, sulphuric acid, and glass—than of ownership of patents and production of novel designs of cell, and firms with lack of capital are therefore heavily handicapped. The "Kartell" for regulation of prices, which was formed early in 1901, had a life of only one year, and failed owing to the price-cutting indulged in by the two outside firms. The heavy fall in the price of lead during 1901 facilitated this collapse, as it enabled the firms in question to underbid the "Kartell." Since February, 1902, free competition has reigned amongst the German firms manufacturing accumulators, many failures have occurred, and much ill-feeling has been caused amongst the survivors. Dr. Peters is of opinion that a second "Kartell" will be formed later on, but that more failures will first occur and that some of the older firms will succumb in the struggle. The new combine will, he thinks, take control not only of prices and production, but also of purchase of raw materials, since contracts for the supply of the whole industry with lead and sulphuric acid could be more favourably entered into when purchasing on such a large scale. While we object, on principle, to "Kartells" for the regulation of production and prices, we admit that they are preferable to the indiscriminate price-cutting which results when production in any industry has greatly outstripped the demand; and the system of regulation by "Kartells," customary in Germany, is at least free from the danger of over-capitalisation, which seems inherent in the English and American system of forming huge trust companies. But if all the weaker firms in Germany have been weeded out, and if the producing capacity of the remaining works is about equal to the demand for their products, why cannot the industry continue its existence without a "Kartell?" Independence of that kind seems to be considered an impossibility in Germany at present, and it is interesting to note that Dr. Peters does not even discuss it. We are afraid that this tendency to rely on artificial aids for industry is contagious, as we can trace its existence in manufacturing circles in this country. If regulation and control are necessary for the maintenance of healthy and flourishing industries in this opening twentieth century, we hope that it will be along the lines of the German "Kartell," rather than on the "Trusts" principle, that the development may occur in this country.

The Crawford-Voelker Lamp.—The following note appeared in the *Scientific American* recently:—"The inventor of the Crawford-Voelker lamp claims to have discovered a method of effecting a chemical union of several rare metals or earths with carbon, thereby obtaining for the first time a true carbide filament. The filaments made under the new process are said to possess a higher specific resistance than carbon filaments; seem to disintegrate much more slowly, and are practically uniform in their resistance. Lamps running to such high voltages as 500 have been successfully made, and apparently do not possess the same delicacy as the 200-volt lamp of commerce. The Crawford-Voelker lamp at the start shows an economy of 39·8 per cent.; after 500 hours of burning there is 50·4 per cent. economy. At the end of 1,000 hours 41·6 per cent. economy is shown. These percentages are based upon tests made by Sir William H. Preece, with lamps of various manufacturers."

We wonder who is responsible for this note, and what Sir W. H. Preece will think of it? We need hardly remind our readers that Sir W. H. Preece never tested the Crawford-Voelker lamp. We do not think he ever will.

College Education.—A correspondent of the New York *Electrical World* (J. H. Armstrong, B.A.), writing on the necessity for maintaining a high standard in American colleges, says:—"It does seem to me to be illogical and foolish for our colleges to lessen the number of years required for graduation. Speaking from experience, I am satisfied that I was poorly enough qualified at the end of four years for post-graduate study, although I was possibly as bright as the average. What seems to be the tendency of the college toward contraction in curriculum is, I believe, only a spurt. Within the second decade of its experience we shall see the climax of the aberration, and the true American college cycling back into line. The prodigal will return to his father's house of his own accord, and the elder brother will frown, but the household will rejoice. To contract the college course is only to cripple the graduate for the work that lies before him."

Electric Heating of Trains.—The Compagnie de l'Ouest (France) is at present making some interesting trials on its electric line between the Invalides and Versailles. The electric heaters are placed on the floor between two seats, each of which accommodates two passengers, so that one footwarmer serves four passengers at the same time. The heating apparatus is composed of a double series of five such heaters in brass, 80 centimetres long by 14 centimetres wide. Each group of five heaters is placed directly in contact with the current of the line at 600 volts; each apparatus works, therefore, at about 110 volts and consumes 1 ampere. The total consumption for the carriage is 1,100 watts. Taking 15 centimes (1½d.) as the price of the kilowatt, the cost is 16·5 centimes (1⅝d.) per hour. It is to be remarked that each group affords heat to 40 passengers.

Institution of Civil Engineers.—The discussion on Mr. T. H. Minshall's paper on "High Speed Generating Plant," which was read before the Institution of Civil Engineers on Tuesday evening, will be continued next Tuesday, when a good debate is expected, as several advocates of American low speed engines have signified their intention to be present.

The Electrical Industry of Switzerland. — The Electro-Technical Society of Switzerland has recently published its thirteenth annual report, the statistics embodied in which prove the flourishing state of the industry in this country. The companies which actually supply electricity number 194; there are also 41 private power transmission plants. The following table shows the power used for generating the energy:—

	Public installation.	Private installation.	Total.
Water power	176	39	215
Gas or petroleum engines ...	13	1	14
Steam	5	1	6
Total ..	194	41	235

The total possible output amounted to 160,900 KW. approximately, including both private and public installations. The following table shows roughly to what use the electrical energy was put:—

For electro-chemical purposes (allowing for 1,500 KW. lying idle on account of the calcium carbide crisis)	24,000	23 %
For electric railways	14,000	14 %
For electric lighting and power	64,700	63 %

London County Council.—The Council decided at the meeting on Tuesday to lend £4,035 to the Battersea Borough Council for electric lighting works and meters.

The adjourned report of the Highways Committee was submitted in relation to the proposed conversion of certain short lengths of tramways to electric traction as set forth in these columns a week ago, the total expenditure being estimated at £133,000. In a report on the prospect of the lines, the Finance Committee stated that the roadwork for the three miles of double track now contemplated is estimated to cost about £4,000 per mile more than the contract rate for the Tooting lines, and about £2,500 more than the estimate for the 19½ miles passed in January last. The excess of the present estimate is stated to be due to the large amount of special work in proportion to the lengths of line, and the allowance for alteration and diversion of gas and water pipes being greater in central districts. It is also considered doubtful whether some portions of the existing concrete and paving can be re-used, and an allowance has been made for possible contingencies, such as night work, &c., and other matters which may be seen to be necessary when drawings have been prepared. It is extremely difficult to estimate what the receipts and expenses will be from these small pieces of track, but the Finance Committee are informed by the tramways manager that the reconstruction and electrical equipment will be of great advantage to the whole of the southern tramway system. The electrification of the Southwark Bridge line will give another terminus nearer to the City than any of the existing termini, and the tramways manager states that a very frequent service will eventually be required over this tramway. The Finance Committee are in some doubt, however, as to the extent of the financial return on the other sections of line. The interest and sinking fund charges on the outlay will amount to about £9,650 in the first year, and they think that in all probability some portion of this sum will really be a charge against the receipts of other sections of the undertaking.

The Bridges Committee presented a report referring to the lighting of various bridges across the Thames. With regard to Waterloo Bridge the Committee stated that it was proposed to complete the electric lighting of the structure by the provision of nine additional standards and lanterns at an estimated cost of £250, whilst the cost of connecting the lamps with the generating station on the Victoria Embankment would amount to £400.

The Highways Committee asked the Council for authority to issue advertisements inviting applications for the position of assistant electrical engineer, at a salary of £500 per annum on the staff of the tramways department. Applicants are to have had both technical and practical training and experience in the designing and construction of electrical machinery, the preparation of specifications and the running, repair and maintenance of electrical plants in general.

Personal.—We understand that Mr. William Young, who was for a number of years with the Edison & Swan Co., has become associated with the "Mackey" lamp, having concluded an arrangement with Mackey's Electric Lamp Co., Ltd., of Bermondsey, to represent them in London and district.

Mr. Wm. Shea, manager of the Blackpool area of the National Telephone Co., has been presented by the staff with a pipe, pouch, and silver matchbox on leaving to take charge of the Stockport area.

Mr. E. P. Martin has joined the board of the South Wales Electrical Power Distribution Co.

Dr. R. J. Ewart, surgical tutor, has been appointed medical officer in charge of the electrical department at the Liverpool Royal Infirmary.

The directors of the South Wales Electrical Power Distribution Co. find their business developing so rapidly that it has been necessary to separate the duties of the general manager and secretary. Mr. Edmund L. Hill, the general manager of the company, who has also been acting as secretary *pro tem.*, has resigned the latter position, and Mr. George P. Tutcher, who has been acting as Mr. Hill's assistant, has been appointed secretary.

An addition to the ranks of telephone experts in this country is made by the return to London of Mr. Herbert Laws Webb, who is spending the winter in England after a long residence in New York, where he has been engaged in telephone work for the past 13 years. The New York telephone system is the largest in the world, having nearly 90,000 stations. Those authorities who are contemplating the establishment of Municipal Telephones should take advantage of Mr. Webb's exceptional telephonic experience, and seek his advice, so as to avoid any uncertainty as to the future of their undertakings. Mr. Webb is also familiar with European telephone methods, as he has made several tours of inspection in Great Britain and on the Continent, and has inspected all the principal European systems; he is the author of a book on the telephone, and of numerous articles in the technical papers. Mr. Webb's address in London is 8, Queen Anne's Gate, S.W.

Mr. M. B. Field, late electrical engineer to the Glasgow Corporation Tramways, was on Monday last presented with a handsome fitted travelling suit case, by the electrical staff of the Department on his leaving to take up an appointment as contract engineer to Messrs. Ferranti, Ltd. Mr. Young, general manager, in making the presentation, spoke of the many friends Mr. Field had made since he came to the Department, and of the regret with which they parted with him. Mr. Field suitably replied. Mr. Field sails for America to-morrow, where he will make a stay of a few weeks, before taking up his new position in London.

Poesy.—We were much gratified to note the bold, soul-stirring, manly verses which appeared last week in an esteemed contemporary, and dedicated to ourselves. The bard, whose initials reveal his identity, is specially endowed with the imagination, the power of rhythmical expression, and the creative faculty of artistic construction which go to make the poetaster. By his powers of insight and expression, and endowed as he is with a vivid and poetical imagination, he is enabled to present ideas on a mere piece of machinery in new, harmonious, and beautiful forms. But whether the poem is didatic, lyric, or epic and dramatic we are for the moment at a loss to decide. Nevertheless, we are filled with noble emotions, and would respectfully ask whether permission would be accorded us to have it set to music. Possibly it might be as difficult to accomplish this with any degree of satisfaction as Sir Alexander Mackenzie found it to be when he undertook to compose the music for Kipling's "Absent Minded Beggar," and there is only one man we would suggest as being capable of performing the task—that Admirable Crichton, the President of the Institution of Electrical Engineers. In our recent biographical notice of Mr. Swinburne, we said: "It is not generally known that he finds relief from a humorous world in the cultivation of a decided musical gift. At one time, indeed, he studied music as a profession. We recently heard a song which struck us as beautiful and musicianly, and having noticed that it bore the initials 'J. S.,' we taxed the President with it. He excused himself by saying that 'Somebody must compose these things.'" We fear, however, the last verse will give him more furiously to think than even the preparation of a Presidential Address! But, as Lowell says, "the desire to poetize is one of the diseases naturally incident to adolescence," and B. C. H. J., after all, is but a youth!

Electric Shock Fatalities.—An arc lamp employé of the Harrogate Corporation died on 28th ult. from an electric shock (2,000 volts) received, it is said, by his hand coming into contact with the live part of a switch box in Victoria Avenue, whilst switching off the electric lights.

At the inquest held last Saturday, Mr. G. S. Ram was present as representing the Board of Trade. The police evidence showed that when Pearson was found, the earthenware shroud of a fuse handle was fractured, and the broken piece was lying in the box. The metal terminal was thus exposed. The medical evidence showed that death was instantaneous, and that deceased's first finger on the left hand was burnt, and that his head was cut as a result of a fall. Mr. G. Wilkinson, borough electrical engineer, said that he was not aware the shroud was broken. The man had rubber gloves, but there was ordinarily no need for him to wear them for the work he had to do. F. A. Lappin, an arc lamp trimmer, said he switched on the lamps on Thursday afternoon. He saw nothing unusual in the box. It was not necessary to take hold of the "shroud" to switch on the lights. Mr. G. S. Ram said that the type of fuse used was a very common one, and it was used in hundreds of cases. The box was conveniently situated, and, in his opinion, Pearson saw the "shroud" was broken, and without thinking put his hand up and touched it. He did not think it had been broken by electrical pressure. To prevent such a thing happening again it occurred to him that it would be advisable for the men to wear rubber gloves, but he agreed with the electrical engineer that it was not necessary in that particular case if everything was in order. He knew there was a difficulty because men did not like to wear gloves. A verdict of "Accidental death" was returned.

On November 27th an employé at the North-Eastern Steel Works, Middlesbrough, came into contact with an electric wire which caused instant death.

Auction Sales.—Messrs. P. Huddleston & Co. will sell by auction at 16, Long Millgate, Manchester, on the 11th inst., electrical plant and apparatus comprising arc lamps, motors, cable and wire, switches, fuseboards, casing, voltmeters, ammeters, telephones, &c. At Springfield Lane, Salford, on the 16th and 17th inst., Messrs. P. Huddleston & Co. will also sell by auction several wire-covering machines and plant, and also 70 tons of copper wire and strip. Mr. A. H. Oldfield will sell by auction at Amberley Road, Armley, near Leeds, on 18th inst., the entire stock of dynamos and motors and electrical goods of Messrs. M. E. Austin & Co. See our advertisement pages this week.

Engineers and the Navy.—Our readers will be pleased to learn that the scheme drawn up by Mr. Rollo Appleyard for the reform of the engineer branch of the Navy is meeting with influential support. Mr Appleyard's name is well known to our readers as that of a contributor to the Electrical Review, and his proposals were detailed in an article which appeared in our columns on February 21st, 1902, with the title "Engineer Officers for the Royal Fleet." The subject received attention at the end of last week in articles in the *St. James's Gazette*, and in the current issue of the *Fortnightly Review*. The scheme is practically this:—

Enter all your men for all branches through the *Britannia*, let them be trained together; let each learn a certain amount of each other's business, and then, after a period of preliminary training, let them specialise, becoming lieutenants (T), (G), (N) or (E), as their idiosyncrasy shall dictate, or, if they have none, let them remain unspecialised, simply to carry out the executive work of the ship, watch keeping, &c.—be "salt-horse" gentlemen, in naval phrase. It follows that you will count all as combatant officers, and will give all authority over the men of their own departments.

In this way you will not only get rid of engineers' grievances, but you will also train your deck officers in the things they ought to know, and be able to put them in charge of the machinery of gun mountings, torpedo tubes, search lights, &c., so far as the ordinary manipulation of them is concerned, confining your lieutenants (E) to their proper work in looking after the generation of power and the big repairs necessary.

The scheme has the support of Commander Orpen and Lord Charles Beresford, and, it is stated, has also been approved by the Admiralty. The need for rectification of the present state of things is recognised by all who have given serious attention to the question, and Mr. Appleyard has our hearty good wishes in the furtherance of his ideas.

Electro-Thermic Manufacture of Steel ("Harmet" Process).—An electric furnace for the manufacture of steel is at present in successful operation at the St. Etienne Steel Works, in France. The process of manufacture was invented by the chief engineer of these works, M. Harmet, and is described in a recent issue of *L'Eclairage Electrique*:—The apparatus comprises three principal parts:—(1) the smelting furnace; (2) the reduction furnace; (3) the electric refining furnace. The raw material is fed into the smelting furnace by a hopper, the lower portion of which forms the vaulted roof of the oven. The floor is circular in shape, and slopes towards the channel leading to the reduction chamber. The gases escaping from the reduction chamber pass through the channel into the smelting furnace, providing enough heat to start the flux. To distribute the heat more evenly throughout the raw material two long carbon electrodes, reaching to the centre of the furnace are introduced, but they act merely as an auxiliary source of heat. The molten metal moves of its own accord down the slope into the reduction chamber, which is cylindrical in shape, and is charged by another hopper with the reduction material, such as coke, charcoal, or anthracite. The floor of the chamber slopes towards the point where the outlet for the molten metal is situated. In the wall, immediately above this outlet, is placed another, through which the slag is carried off. Two carbon electrodes are fixed in such a manner that the arc is close to the surface of the molten mass. From this chamber the metal passes into the refining or regulating furnace, which is provided with a certain quantity of ore for decarburation purposes. The vaulted roof of this oven is pierced by two carbon electrodes, the points being close to the surface of the flux. The furnace is provided with two outlets, one for the slag and one for the metal. The inventor gives the following particulars regarding the cost of steel produced by this process:—The electrical energy required for the manufacture of a ton of steel amounts to 3,600 H.P.-hours. Taking the cost of coke at 25 frs. per ton, and of energy at the usual price charged in that district, where the works are situated, the cost of 1 ton of steel amounts to 29 24 frs. (£1 3s. 4·7d.):—

360 kg. of coke at 25 frs. per ton ...	9.00 frs.	
2,024,500 calories at 0.01 fr. per 1,000 calories	20.24 „	
Total	29.24 frs.	= £1 3 4·7

The cost of steel produced in an ordinary furnace amounts to 42 50 frs.:—

1,000 kg. of coke at 25 frs. per ton...	25 frs.	
Furnace machinery	5.00 „	
500 kg. of coal at 25 frs. per ton ...	12.50 „	
Total	42.50 frs.	= £1 14 0

This shows a saving of 13.26 frs. (10s. 7·3d.) per ton in favour of the electric process.

A New Photo-Electrical Cell.—There have been made endeavours for some time past to introduce the selenium cell into electrical engineering practice; on account of its insufficient reliability and the inconstancy of the types so far in use, these endeavours, however, failed to succeed. E. Ruhmer describes in the *Elektrochemische Zeitschrift* a new type, which seems to be particularly fitted for practical use. This cell is of a cylindrical shape, and may be adapted to any glow-lampholder. Its durability is almost unlimited, and its sensibility, though the resistance is relatively low, is of a high order, so as to respond readily to the slightest variations of illumination. It is therefore particularly suitable for wireless telephony with speaking arc lamps and parabolic mirrors. The accuracy and intensity of the sounds thus transmitted aroused unanimous admiration at a recent exhibition in the Berlin Architektenhaus. The electrical resistance of such a cell, as is known varies to a great extent according to the illumination, the conductivity of a good cell, when illuminated, being as much as 10—30 times its value in the dark. This property may be made use of by causing the variations of resistance to act on a suitable relay, so as to release mechanism by luminous rays. Gas and electrical lamps may thus be lighted and put out automatically at a distance, at nightfall and daybreak respectively. There have recently been carried out some wireless telephony experiments with these cells on Lake Wannsee, near Berlin. The variations of intensity in the light of a projector fixed on board an accumulator boat, due to the working of a microphone, were converted into current oscillations in the selenium cell placed at the receiving station, telephonic conversations being thus exchanged over a distance of 4·5 km. without reaching the limits available, and it is intended to extend those experiments on a still wider range in the near future.

The Education of Schoolmasters.—Mr. Jerome, the well-known humourist, has shown that not all his thoughts are those of an idle fellow; for in a recent book he has taken the opportunity of criticising apparently in all seriousness the educational methods which obtain in so many middle-class private schools. "Half our time," he says, "was taken up in studies utterly useless to us"; and he asks the schoolmaster why, out of the vast storehouse of really necessary knowledge, he cannot select some apparatus better fitted than Latin and Greek to strengthen the mental muscles from 10 to 14. The question is a pertinent one, although perhaps it needs to be answered by the headmasters of our large public schools rather than by those of private seminaries, since it cannot be denied that for sheer education and mental training the methods of the best private schools stand before those of the larger institutions. Still, a schoolmaster cannot teach what he does not understand, nor will he attempt to understand a subject whose value he does not appreciate. Schoolmasters, clergymen, and great mathematicians are alike in being hopelessly ignorant of this world's affairs: conspicuous examples to the contrary proving the correctness of the generalisation. For nine months in every year the schoolmaster associates with boys only, and soon forgets there are grown-up men outside his walls: like the parent, he never realises that his boys become adult. Just as it is the employer of labour who requires to be given a technical education, so it is the teacher of boys who needs an education in the conditions of modern competitive life. School Boards teach their teachers how to teach; we want an establishment which shall be able to teach teachers what to teach. And we also need some process for instilling into the minds of parents that the true test of an educational method is the success achieved by the scholars in after life, not the facility with which the older boys pass general examinations.

Water-Tube Boilers in the U.S. Navy.—The annual report of the Bureau of Steam Engineering, 1902, has been issued from the U.S. Navy Department. Great stress is laid on the work of the British Boilers Commission, which has probably prevented any consideration of the Belleville boiler in the U.S. Navy. It is specially recommended that, if possible, the water-tube boiler selected should be of American design. Three types of water-tube boiler are already being built for battleships in course of construction. The proportion is four-sevenths Babcock & Wilcox, two-sevenths Niclausse, and one-seventh Thornycroft. The Hohenstein boiler has now been offered and tested in an airtight steel house, resembling the firehold of the cruiser *Denver*. The boiler is made by the Oil City Boiler Works, who are willing to spend £10,000 to £20,000 in proving the fitness of the boiler for naval purposes, or the reverse. The Hohenstein boiler contains two 24-in. steam drums connected by four 16-in. drums, and one lower mud drum of 24 in. diameter. It has 384 tubes of 2 in. diameter, 9 ft. long, and 16 tubes of 4 in. diameter, 7 ft long, which start from the lower drum and form the furnace crown. These tubes feed the headers of a set of > tubes. Another oppositely sloping set of tubes is fed direct from the lower drum, which is in turn filled by down-comers from the upper drums. The boiler occupies a floor space of 9 ft. × 11 ft., with a height of 12 ft., and has 2,174 sq. ft. of surface, with 50 of grate area—the ratio being 42·5. Various baffles are employed to distribute the gases over the tube surface, but the provision for perfect combustion is at most not excessive. A fan was provided to force combustion, and an air lock entrance was provided. The coal used possessed a calorific capacity of about 14,500 B.Th.U. per lb. The boiler was worked up to 270 lbs. pressure, and evaporated, with a draught of 1·1 W.G., as much as 1,400 lbs. of water per hour per square yard of floor surface occupied. Seventeen tests in all were made, showing from and at evaporation between 8·33 and 10·20 lbs. per lb. of coal, and from 4·38 to 14·15 lbs. of steam per square foot of heating surface. It is curious how all boilers give such similar results in output and efficiency, the largest output corresponding with an efficiency of 59·4 per cent., and generally all the important results being repetitions of what other boilers will do. A good deal of smoke seems to have been recorded.

Royal Society.—The annual meeting of the Royal Society was held on Monday. Sir William Huggins was re-elected to the presidency, and delivered his annual address. The various medals of the Society were presented. In the evening the annual banquet of the Society took place at the Hôtel Métropole. Sir W. Huggins again presided.

British Locomotives.—The British Government has ordered 60 locomotives (about £250,000) for South Africa. Scotch wagon builders also have received good orders. So the British-built locomotive is beating the foreigner after all!

Electrical Volunteers (R.E).—In the House of Commons on 26th ult., Sir J. Leng asked the Secretary for War whether he was aware that five companies of electrical engineers in South Africa, nearly all highly skilled professional men, who gave up lucrative appointments for the service of their country, received ordinary soldiers' rate of pay; that they furnished upwards of 80 working parties, and successfully carried out all kinds of electrical installations for light, power, and communication in connection with hospitals, bridges, camps, and blockhouses over an extensive territory; and whether any volunteer officer or man in this recently-returned battalion had received any distinction or reward; and, if not, whether it was contemplated to recognise their services in any way. Mr. Brodrick, in reply, said:—The electrical engineers received the ordinary rates of pay, like the other volunteers serving in South Africa. The valuable and excellent work performed by them was fully appreciated by Lord Kitchener. Three officers were mentioned in dispatches, and the sergeant-major received a distinguished conduct medal. In view of the scale on which rewards were available, it was not found possible, in justice to others, to grant further rewards.

America v. Germany.—A Continental correspondent writes:—"The American electrical firms in Germany have replied in a practical way to the ultimatum of the German electrical firms that have formed a combine to eject them from the German markets. One of the biggest American firms has just bought samples of all varieties of German motors and electrical machinery for the purpose of duplicating the models in the American workshops. The one drawback the American firms had to contend against was the inadaptability in many cases of the American motors and American electrical accessories to German shops and methods. The defect is now to be remedied by the special manufacture of motors and machinery in American shops to supply German markets. But the real significance of this move is the fact that it is the reply of the American companies to the challenge of the German firms, which try to force the former companies out of business by forming a combine among themselves. The competition will now become a matter of low contracts and cheap sales."

B.E.T. Conversazione.—This conversazione was held on Monday, December 1st, at the Galleries of the Royal Institute of Painters in Water Colours, at Princes' Hall, Piccadilly, and was attended by a large gathering of the officials of the British Electric Traction Co. and their lady friends. The pictures were greatly admired, while the band and the refreshments came in for no small share of appreciative attention. The steady buzz of conversation afforded ample proof that the guests were enjoying themselves in sociable chat, and we venture to congratulate the company on the success of its effort, the mutual friendship, and *bonne camaraderie* of its large staff.

THE CENTRAL STATION ENGINEER.

THE Hammersmith Borough Council has confirmed the appointment of Mr. R. H. PATERSON, late assistant engineer of the Dewar Place electricity station of the Edinburgh Corporation, to the post of station superintendent.

Consequent on the appointment of Mr. GRIFFEN as chief electrical engineer to the Swindon tramways, Mr. J. E. STARKIE, now second assistant, has been appointed chief assistant at the Burnley Electricity Works, at a salary of £125 per annum, rising to £130.

The Law and Finance Committee of Greenock Corporation has added to the short leet of applicants for the post of electrical engineer the names of Messrs. R. A. D. MACALISTER, ALEXANDER ANDERSON, and DAVID SCOTT, all assistants at Greenock Electricity Works.

Mr. W. H. TITTENSOR, of Dundee, has been appointed resident electric tramways engineer by the Preston T.C. The appointment is for three years at £600 per annum.

Mr. FREDK. COMFORT, chief inspector of the National Telephone Co. at Nottingham, has been appointed mains superintendent at the Nottingham Corporation Electricity Works. Mr. Comfort's successor, under the telephone company, is Mr. JOHN DRING.

Mr. R. PAPE has been appointed borough electrical engineer at Morecambe—a step rendered necessary by the incorporation of the town—at the same salary that he received under the late U.D.C.

NEW COMPANIES REGISTERED.

Carl Oppermann Electric Carriage Co., Ltd. (75,440).—This company was registered on November 17th, with a capital of £50,000 in £1 shares, to acquire and carry on the business of an electrical engineer and motor-carriage maker carried on by C. T. J. Oppermann, at 2, Wynyatt Street and Rawstone Street, Clerkenwell, to acquire and turn to account three inventions of the said C. T. J. Oppermann for an improvement (1) in electrical controllers, (2) in motor road vehicles, and (3) in secondary batteries, and to carry on the business of producers and suppliers of electricity, electrical and mechanical engineers, dealers in electrical, magnetic, telegraphic, telephonic and other appliances, &c. The first subscribers are [illegible] race, W., gentleman, with 300 shares; H. F. Slattery, Ravenshill, Chislehurst, Kent, banker, with 100 shares; V. Kesterton, 479, Oxford Street, W., coachbuilder, with 50 shares H. J. Harvey, 479, Oxford Street, W., coachbuilder, with 100 shares; Mrs. E Robins, West Hill Lodge, Brighton, with 100 shares; H. D. Lermitte, Frowick North Mymms, Hatfield, gentleman, with 100 shares. No initial public issue The first directors are H. D. Browne, H. D. Lermitte and C. T. J. Oppermann qualification, £1,000; remuneration of chairman, £100 per annum; of ordinary directors, £50 each per annum. Registered office, 30, Moorgate Street, E.C.

Londonderry—Moville Electric Railway Syndicate, Ltd. (75,455).—This company was registered on November 18th, with a capital of £10,000 in £1 shares, to take over all work already done in connection with the Londonderry and Moville Electric Railway scheme, to apply to the Irish Privy Council for an order to construct and work an electric or steam railway between Londonderry and Moville in perpetuity, to promote a larger company to take over the said order when obtained, and to carry on the general business of railway, tramway and light railway proprietors, &c. The first subscribers (each with one share) are:—W. O'Doherty, M.P., Commercial Buildings, Foyle Street, Londonderry, solicitor; R. N. Chambers, Kt., J.P., 15, Queen Street Londonderry, town clerk; T. C. Wylie, Culmore, Londonderry, solicitor; H Chambers, Londonderry, managing director of Andrew A. Watt & Co., Ltd. G. V Craig, Londonderry, Under-Sheriff; N. McColgan, J.P., 8, Foyle Street Londonderry; and C. O. Bastian, Bartholomew Works, Kentish Town, N.W. managing director of Bastian Meter Co., Ltd. Minimum cash subscription £1,500; the number of directors is not to be less than two nor more than five the subscribers are to appoint the first: remuneration according to profits Registered office, 20, Bucklersbury, E.C.

Metropolitan Electric Tubes Syndicate, Ltd. (75,456).—This company was registered on November 18th, with a capital of £15,000 in 14,000 ordinary shares of £1 each and 20,000 deferred shares of 1s. each; to adopt an agreement with T. Hunter to apply for powers relating to the construction and maintenance of railways, tramways, electric lighting, and other electrical installations, &c., and to carry on the business of contractors, electricians, engineers, founders, promoters, financiers, &c. The first subscribers (each with one share) are:—T. Hunter, Dorman's, Dorman's Land, East Grinstead, accountant; J. J. Ney, 70, Bishop's Road, Fulham, S.W., marine engineer: H. W. Healy, 42, Danemere Street, Putney, S.W., engineer's student J. C. Shirle, 88, St. Stephen's Avenue, Shepherd's Bush, W., gentleman C. Everett, 25, Great Tower Street, E.C., book-keeper L. Everett, 3, Crooke Lane Chambers, E.C., gentleman; and A. L. Pinn, 8, Fairmead Road, N., civil engineer. No initial public issue. Registered without articles of association.

Electric Traction Co. of Hong Kong, Ltd. (75,486).—This company was registered on November 20th, with a capital of £325,000 in £1 shares, to adopt an agreement with the British Corporation Ltd., to construct or acquire and maintain by electrical, horse, steam, or other power any tramways, railways, and other means of communication, to act as carriers of passengers and goods, to construct and control public works and conveniences, to generate, accumulate, and distribute electrical energy for light, power, heat and otherwise, &c. The first subscribers (each with one share) are:—W. J Baxter, 84, Queen's Road, Notting Hill, W., clerk; H. Birnage, 3, Gainsboro Road, Leytonstone, clerk; E. J. Hayman, 8, Knatchbull Road, Camberwell clerk; H. S. Heywood, 302, Goldhawk Road, W., clerk; F. J. C. Jeffrey, 17 Tressillian Road, St. John's, S.E., clerk; B. T. Hewett, 94, Denbigh Street S.W., clerk; and A. E. Dorney, 9, Chandos Road, Willesden Green, N.W. clerk. No initial public issue. The number of directors is not to be less than two nor more than nine; the subscribers are to appoint the first. Remuneration, £200 each per annum, and £100 extra for the chairman.

North-West London Electric Supply Co., Ltd. (75,501).—This company was registered on November 21st, with a capital of £75,000 in £ shares (20,000 preference), to carry on in the County of London or elsewhere the business of an electric light company in all its branches, to construct, lay down, establish, fix and carry out all necessary cables, wires, lines, accumulators works, lamps, machinery and other appliances, to generate, accumulate, distribute and supply electricity, to light cities, towns, streets, docks, markets theatres, buildings and public and private places, &c. The first subscriber (each with one share) are:—A. H. Neale, 6, Great Winchester Street, E.C. merchant; A. G. Spilsbury, 37, Abbey Road, N.W., gentleman; G. W. Cuddon 10½, Fenchurch Street, E.C., gentleman; J. E. Reilly, 6, Lothian Road, North Brixton, S.W., secretary; H. A. Todd, The Nook, Southville Road, Thames Ditton, clerk; T. H. Hazelton-Black, 7, Laurence Pountney Hill, E.C., engineer and E. Stone, 16, Babbacombe Road, Bromley, Kent, accountant. No initial public issue. The number of directors is not to be less than two nor more than six; the subscribers are to appoint the first; qualification, 250 shares; remuneration, £75 each per annum (£50 extra for the chairman), and a share in the profits. Registered office, 5 and 6, Great Winchester Street, E.C.

Electrical Mining Co., Ltd. (75,544).—This company was registered on November 27th, with a capital of £5,000 in £1 shares, to acquire the business of manufacturers of, and agents for electrical and general mining apparatus, appliances and the like, carried on by W. H. de Grave, L. W. de Grave, and C. A. Newton, 9, Irongate, Derby, as the "Electrical Mining Co.," and to carry on the same and any kindred business. The first subscribers (each with one share) are:—W. E. H. de Grave, 21, King Street, Wakefield, electrical engineer; C. A. Newton, Tull Street, Derby, electrical machinery manufacturer; L. W. de Grave, 9, Iron Gate, Derby, electrical and mining engineer Miss M. Hough, Chatillon, Bromley Street, Derby; Mrs. F. Wood, Welbeck House, Dale Road, Brixton; R. Newton, Tull Street, Derby, electrical machinery manufacturer; and H. Newton, Tull Street, Derby, electrical machinery manufacturer. No initial public issue. The first directors are W. E. H. de Grave, L. W. de Grave, and C. A. Newton.

Empire Electric Light and Power Co., Ltd. (75,545.)—This company was registered on November 27th, with a capital of £50,000 in £ shares, to promote and obtain power to construct, maintain and use tramways in and near Romford and Ilford or elsewhere, to make and maintain railways and tramways, with their appurtenances, to equip and work the same by any power, &c.—The first subscribers (each with one share) are:—T. H. Harrison, Belle Vue, The Grove, Wandsworth, S.W., engineer; P. C. Whitaker, 43, Englefield Road, N., clerk; C. W. Pullen, 71, Elspeth Road, Lavender Hill, S.W., clerk; W. R. Woolston, 30, Queen's Road, Leytonstone, clerk; H. C. Armstrong, 50, Eaton Terrace, S.W., solicitor; S. J. Drinkwater, 31, Oldfield Road, Stoke Newington, N., gentleman; and F. McDaniel, 5, Mansford Street, N.E., clerk. No initial public issue. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first. J. Paxman, of the Standard Ironworks, Colchester, and A. Slatter, of 11, Buckingham Street, W.C., are entitled to become permanent directors if they so desire; qualification, £200; remuneration, £100 each per annum (£150 for the chairman), with an increase according to profits.

Milnes-Daimler, Ltd. (75,547).—This company was registered on November 27th, with a capital of £20,000 in £10 shares, to manufacture, build, sell, buy, let or take on hire and otherwise deal in and with motors, coaches, carriages, tramcars, locomotives, carts, wagons, ships, boats, launches, cycles, air-ships, &c., to acquire all or part of the property comprised in an agreement made November 10th, 1902, between George F. Milnes & Co., Ltd., of the one part, and the Daimler Motoren Gesellschaft of the other part, to construct or acquire railways and tramways, to carry on the business as electricians, electrical and general engineers and contractors, &c. The first subscribers (each with one share) are:—H. G. Burford, 24, Pennard Road, Shepherd's Bush, W., engineer; R. Bell, 58, Richmond Gardens, Shepherd's Bush, W., engineer; J. J. Russell, Smithe House, Rusthall Avenue, Bedford Park, W., accountant; F. W. Ford, 22, Circus Street, Marylebone, W., clerk; J. Lane, 4, Jameson Street, Notting Hill Gate, W., storekeeper; G. J. Brown, 12, Cranbrook Road, Chiswick, W., electrical engineer; and J. T. Smith, 11, Crescent Mansions, Elgin Crescent, W., engineer. No initial public issue. The number of directors is not to be less than two nor more than nine; the first are M. von Dattenhofer, E. Kraftmeier, H. Meltzer, J. T. Smith, and H. H. Burford.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Industrial Electric Co., Ltd. (73,266).—£60 debentures, created 23rd, and dated October 21th, 1902, charged on the company's property, present and future, have been registered. No trust deed. Holders: J. Leith and C. J. Holmes.

Electric Lighting Boards, Ltd. (64,543).—Issue on November 18th of £400 debentures, part of a series created March 10th, 1902, to secure £.0,000, charged on the company's undertaking and property, present and future, including uncalled capital. Date of trust deed, March 18th, 1902. Trustee, Gen. S. J. Nicholson, Harlow, Essex. Total amount previously issued of same series, £19,400.

St. Helens Cable Co., Ltd. (62,471).—Issue on October 28th of £12,000 debentures (24 of £500 each) part of a series created October 27th, 1902, to secure an unlimited amount. Property charged: the company's undertaking and property, present and future, including uncalled capital. Holders: W. W. Pilkington, St. Helens (£6,000); and J. Beecham, St. Helens (£6,000). No trustees. Total amount previously issued of same series, £134,000.

Vaughan & Son, Ltd. (61,526).—This company's annual return was filed on October 30th, when 3,595 preference and 19,049 ordinary shares were taken up out of a nominal capital of £50,000 in 20,000 preference and 30,000 ordinary shares of £1 each. £1 per share has been called up, resulting in the receipt of £22,644. Mortgages and charges, £5,082 14s. 1d.

Ernest Scott & Mountain, Ltd. (32,760).—This company's annual return was filed on October 17th, when 9,779 shares were taken up out of a nominal capital of £100,000 in 10,000 shares of £10 each. £10 has been called up on 7,579 shares, resulting in the receipt of £75,580. £260 remains in arrears. £4 10s. has been paid on one forfeited share. £22,000 is considered as paid on 2,200 shares. Mortgages and charges, £20,600.

Jandus Arc Lamp and Electric Co., Ltd. (43,898).—This company's annual return was filed on November 4th, when 2,041 shares were taken up out of a nominal capital of £30,000 in 3,000 shares of £10 each. £5 per share has been called up on 1,195 and £10 per share on 250 shares, resulting in the receipt of £8,475. 596 shares are considered as fully paid. Mortgages and charges, £8,000.

Mather & Platt, Ltd. (60,387).—This company's annual return was filed on September 19th, when 32,505 preference and 40,000 ordinary shares were taken up out of a nominal capital of £775,000 in 37,500 preference and 40,000 ordinary shares of £10 each. £10 per share has been called up on 21,705 preference and 2,500 ordinary shares, resulting in the receipt of £242,050. £483,000 considered as paid on 10,800 preference and 37,500 ordinary shares. No mortgages or charges.

Lancashire Electrical Engineering Co., Ltd. (5,692).—This company's annual return was filed on September 20th, when 1,883 shares were taken up out of a nominal capital of £5,000 in 5,000 shares of £1 each. £1,883 is considered as paid. No mortgages or charges.

Langdon-Davies Motor Co., Ltd. (55,830). — Issue on November 5th of £900, and on November 6th of £300 debentures, part of a series created October 15th, 1904, to secure £6,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £2,000.

Midland Electric Corporation for Power Distribution, Ltd. (53,071).—A debenture dated November 13th, 1902, to secure £100,000, has been registered. Property charged: The company's undertaking and property, present and future, including uncalled and unpaid capital. Holders: Parr's Bank, Ltd., 4, Bartholomew Lane, E.C.

Electric Lighting Boards, Ltd. (64,543).—Issue on October 31st, of £200 debentures, part of a series created March 10th, 1902, to secure £20,000, charged on the company's undertaking and property, present and future, including uncalled capital. Date of trust deed, March 18th, 1902. Trustee: General S. J. Nicholson. Total amount previously issued of same series, £19,200.

C. & A. Musker (1901), Ltd. (70,573), Mechanical, Hydraulic and Electrical Engineers.—Issue on November 5th of £1,000 debentures, part of a series created July 5th, 1901, to secure £40,000, charged on the company's undertaking and property, present and future, including uncalled capital. Date of trust deed: July 8th, 1901. Trustees: The Law Guarantee and Trust Society, Ltd. Total amount previously issued of same series: £31,000.

Welsh Electric Traction Co., Ltd. (68,292).—A floating charge on the company's undertaking and property, including uncalled and unpaid capital (subject to prior charge for £12,000), dated October 31st, 1902, to secure £338 18s. 3d., has been registered. Holder: J. C. Howe.

South African Lighting Association, Ltd. (27,609), Gas, Electric, or other Lighting.—Issue on October 29th of £1,000 new debentures, and on November 5th of £924 renewals of debentures, part of a series created August 12th, 1890, to secure £20,000, charged on the company's undertaking and property. No trustees. Total amount previously issued of same series, £19,000.

British Electromobile Co., Ltd. (67,650).—A memorandum of satisfaction in full of a mortgage debenture dated January 6th, 1902, securing £5,000, has been filed.

Bastian Meter Co., Ltd. (53,304).—Issue on November 14th of £100 debentures, part of a series created by resolutions of April 22nd, May 23rd and June 10th, 1901, to secure £5,000 charged on two pieces of ground at Kentish Town with building thereon, known as 24, Bartholomew Villas, and all other assets, present and future, including uncalled capital. Date of trust deed: December 30th, 1901. Trustees: H. A. Saunders and D. J. Cowles. Total amount previously issued of same series: £4,550.

Bright's Light and Power, Ltd. (58,290).—A second debenture, dated November 19th, 1902, to secure £1,000 charged on the company's concessions, freehold and leasehold property, works and plant in England and elsewhere, and its other property and undertaking, including uncalled capital, has been registered. Holder: C. Owles, 16-17, Russell Street, W.C.

SUPPLY STATION ACCOUNTS.

Bath Corporation Electricity Accounts.

The accounts for last year of the electricity department of the Corporation of Bath show the satisfactory result that the year's working has, firstly, been productive of a net profit instead of a net loss; secondly, that the costs of production have actually been reduced in the gross; and thirdly, that very material increases in the revenue and in the output have been made. Notwithstanding the engineering difficulties under which he has laboured, Mr. Francis Teague, the city electrical engineer, has achieved an almost remarkable success, and we congratulate him upon the improved figures.

The capacity of the plant remains at the figure of 1,000 KW.

General Statement.

	1900.	1901.	Inc.
Total capital expenditure ...	£78,450	£92,904	£14,454
Number of units sold	606,876	743,607	136,731
No. of 8-C.P. lamps connected ...	24,698	36,569	11,871
Maximum load in KW.	493	634	141
Gross revenue	£11,763	£13,082	£1,319
Gross expenditure...	£7,419	£7,052	—£367
Gross profit	£4,344	£6,030	£1,686
Average price per unit sold ...	4·31d.	4·05d.	—·26d.

The increase in revenue of £1,651 from sales of energy alone is almost equal to the additional gross profit. In other words, the cost of providing the extra units sold has been met by economies in generation and the augmentation in revenue has gone to swell the profit account. The average return per unit from sales of energy has fallen to just over 4d., and the drop of more than a ¼d. should encourage the demand.

The street lighting has been increased from 155 to 177 arc lamps of 630 watts each, charged at the rate of £25 per annum. The private rates are, for lighting, 5d. per unit, and for power 2½d. per unit, this being a reduction of ½d. on the previous year's figure.

Revenue Statement.

	1900. Gross.	1900. Per unit.	1901. Gross.	1901. Per unit.	Inc.
Sale of energy	£10,903	4·31d.	£12,554	4·05d.	—·26d.
Meter rents	375	·15d.	854	·11d.	—·04d.
Sale of lamps, &c.	57	·02d.	148	·05d.	+·03d.
Sundry discounts and interest.	428	·17d.	26	·01d.	—·16d.
Gross revenue ...	£11,763	4·65d.	£13,082	4·22d.	—·43d.

The cost sheet shows reduced expenditure in all items except repairs. The total has fallen from £7,419 to £7,052, notwithstanding an increase in the units sold from 606,876 to 743,607 units. The two changes have brought the works costs down from 2½d. to under 1¾d., and the total cost from nearly 3d. to almost 2¼d. per unit, reductions of no less than practically ½d. and ¾d. respectively. The most marked changes are in salaries, where £119 have been saved, or taking the outputs in consideration, say, ⅓d. per unit; and coal, where the bill is now only about two-thirds of the previous year, being over ½d. per unit less. These are exceptionally good figures to attain in one year's working.

Cost of Production.

	1900. Gross.	1900. Per unit.	1901. Gross.	1901. Per unit.	Inc.
Coal	£3,075	1·22d.	£2,098	·68d.	—·54d.
Oil, waste, water, and engine room stores.	519	·20d.	550	·18d.	—·02d.
Salaries and wages incurred in generation and distribution and attending, &c., public lamps.	1,441	·57d.	1,602	·52d.	—·05d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	532	·21d.	1,044	·34d.	+·13d.
Works costs ...	£5,567	2·20d.	£5,294	1·72d.	—·48d.
Rent, rates and taxes ..	276	·11d.	273	·09d.	—·02d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	1,369	·54d.	1,250	·40d.	—·14d.
General establishment charges, stationery and printing, law charges and insurance.	203	·08d.	229	·07d.	—·01d.
Other expenses, certification of meters, &c.	4	·00d.	6	·00d.	·00d.
Total costs ...	£7,419	2·93d.	£7,052	2·28d.	—·65d.

The deficit from the previous account of £1,239 has been wiped out by a sum received, and on the year, the increase in gross profit of £1,686, coupled with a fall in the financial charges of £450, has enabled the net loss of £1,239 in 1900 to be converted into a net profit of £897. Of this sum £40 has been allocated to cover bad debts, and the remainder, or £857, is carried forward.

Profit Statement.

	1900.	1901.
Interest on loans	£3,178	£2,728
Sinking fund for repayments	2,405	2,405
Net profit carried forward	—1,239	897
Gross profit	£4,344	£6,030

St. Helens Corporation Electricity Accounts.

The output at St. Helens has now passed the million unit limit, and the increase of nearly a third of a million units in one year has had a very marked effect upon the accounts. The financial results are, however, influenced by that feature so common in the last year or two, a diminution in net profits owing to a rapid rise in the demand made upon the gross profit by the charges due for interest, and accruing from sinking fund. The effect of capital expenditure becomes more apparent as the receipts per unit fall, and the margin between gross profit, one year and another, smaller. The traction load is a valuable source of revenue at St. Helens, and it may be remembered that the cars are run by a local company, while the Corporation maintains the track and all the overhead plant. The traction figures are:—

Tramway sales by contract.	Rents received from traction.	Maintenance of overhead equipment.	Capital invested in—
827,837 units.	£2,165	£925	Traction plant, £24,215 Line equipment, £36,272

The growth during the past year is shown by:—

General Statement.

	1900.	1901.	Inc.
Total capital expenditure ...	£100,176	£123,547	£23,371
Number of units sold	910,736	1,287,965	£327,229
Number of 30-watt lamps connected	21,229	—	—
Maximum load in KW.	675	792	117
Gross revenue	£10,850	£13,159	£2,309
Gross expenditure	£4,814	£6, 43	£1,529
Gross profit	£6,036	£6, 16	£780
Average price per unit sold ...	2·81d.	2·07d.	−·74d

Owing to the increase in low-price units, the receipts from sale of energy have fallen by nearly the third of a penny, the other items in the revenue account remaining practically unaltered. The output was distributed thus:—

Year.	Private consumers.	Street lamps.	No. of street lamps.	Traction sales.
1898	60,296	4,795	4	—
1899	112,920	25,110	35	182,076
1900	160,298	51,290	35	599,042
	100,106 motors			
1901	355,095	55,033	35	827,837

Revenue Statement.

	1900. Gross	1900. Per unit.	1901. Gross.	1901. Per unit.	Inc.
	£		£		
Sale of energy .. .. / Traction rent	10,654	2·81d.	10,667 / 2,165	2·07d / ·42d.	−·32d.
Meter rents	90	·02d.	121	·02d.	·00d.
Sale of fittings, hire of motors, &c.	30	·01d.	45	·01d.	·00d.
Sundry, repairing public lamps, special interest, &c.	76	·02d.	161	·03d.	+·01d.
Gross revenue ...	£10,850	2·86d.	£13,159	2·55d.	−·31d.

The costs have fallen slightly, the principal alterations being a reduction of $\frac{1}{10}$d. in coal, bringing this item down to just over ½d., and increases in repairs—now the heaviest item of expenditure both in the actual amount paid and per unit—and salaries. Neither of these is to be regretted, as they tend towards reliability and efficiency, and, by their increase, no doubt assist to bring down the other engineering costs.

Cost of Production.

	1900. Gross.	1900. Per unit.	1901. Gross.	1901. Per unit.	Inc.
Coal..	£1,343	·36d.	£1,325	·26d.	−·10d.
Oil, waste, water, and engine room stores.	195	·05d.	184	·03d.	−·02d.
Salaries and wages incurred in generation and distribution.	712	·19d.	856	·17d.	−·02d.
Repairs and maintenance of engines, boilers, dynamos, buildings, and overhead equipment.	1,144	·30d.	1,941	·37d.	+·07d.
Works cost ...	£3,394	·90d.	£4,306	·88d.	−·07d.
Rent, rates and taxes ..	415	·11d.	414	·08d.	−·03d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	542	·14d.	1,171	·23d.	+·09d.
General establishment charges, stationery and printing, law charges and insurance	373	·10d.	395	·08d.	−·02d.
Other expenses: superannuation fund, subway account, &c.	90	·02d.	57	·01d.	−·01d.
Total costs ...	£4,814	1·27d.	£6,343	1·23d.	−·04d.

The increase in revenue amounted to £2,309, and in expenditure to £1,529, leaving a difference of £780 to swell the gross profit. This, however, was insufficient to meet the additional financial charges of £1,739, and the balance of £959 had to come from what was the previous year's net profit, so that the financial result leaves only £261 to be carried forward.

Profit Statement.

	1900.	1901.
Interest on loans, overdraft and deposits	£2,153	£3,290
Sinking fund for repayments	2,663	3,265
Net profit carried forward	1,220	261
Gross profit	£6,036	£6,816

CITY NOTES.

British Westinghouse Electric and Manufacturing Co., Ltd.

The third annual report of the directors "for the year ending July 31st, 1902," reads as follows:—

"Pending the completion of the company's works at Manchester, orders have been executed at Pittsburg on terms whereby the British company has shared with the American company the manufacturing profits. The company's works at Manchester are practically completed, and manufacturing operations have begun. About 3,000 men are already employed, and all orders can now be executed there, thus securing to this company the whole of the manufacturing profit, instead of a part only. The following particulars indicate the growth of the company's business:—

Orders received during the year ending July 31st, 1899, £279,000
Orders received during the year ending July 31st, 1900, £547,000
Orders received during the year ending July 31st, 1901, £738,000
Orders received during the year ending July 31st, 1902, £932,000
and
Orders received since July 31st, 1902, exceed £825,000.

"A construction department has recently been organised under the management of Mr. James C. Stewart to carry out building and general construction, thus enabling the company to undertake the complete installation of large railway, power and lighting plant. Among important contracts obtained in the past year by the company are those with the Metropolitan District Railway Co., the Metropolitan Railway Co., the Clyde Valley Electrical Power Co, the London United Tramways Co., Ltd., the Bath Tramways Co., Ltd., Exeter Corporation, Newcastle Corporation, Swansea Corporation. In December, 1901, the company issued 50,000 6 per cent. preference shares of £5 each, thus completing the issue of £1,000,000, the total authorised preference share capital, and subsequently, in February, 1902, £500,000 4 per cent. mortgage debenture stock was issued. The company's profits for the year amount to £60,6:6 7s. 1d. Adding to this the sum of £18,908 4s. 6d. brought forward from last year, the total to the credit of profit and loss is £79,594 11s. 7d. Out of this sum an interim dividend of £23,257 16s. 4d. and debenture interest to the amount of £6,132 4s. 1d. have been paid, and the directors propose to appropriate a further sum of £30,000, making the full 6 per cent. upon the 200,000 preference shares as fully paid up on July 31st. Out of the balance remaining, amounting to £20,204 11s. 2d., the directors have decided to write off £14,963 17s. 6d., the amount of the stamp duties and fees incurred on the formation of the company, and the expenses connected with the debenture issue, and to place the balance of £5,240 13s. 8d. to reserve account. The rapid growth of the company's business necessitates an increase of capital, and the directors will propose to the meeting that an additional 200,000 6 per cent. preference shares of £5 each, ranking *pari passu* with those already existing, shall be created, but it is not intended to issue more than one-half of such shares at present. It will be seen from the figures in the balance-sheet that the erection and equipment of the works at Trafford Park have absorbed the bulk of the available capital. The extensive business in hand, as well as new business in prospect—all of which is to be executed at the company's works—will require additional funds for material, labour, and working capital generally. The directors believe that the use of such additional capital will result in a higher percentage of profits. In December, 1901, Mr. Lemuel Bannister retired from the board, and Lieut.-Colonel Montagu Cradock, C.B. (a director of the Westinghouse Brake Co., Ltd.), has been appointed to fill the vacancy, an appointment which will be submitted for approval at the meeting. In pursuance of the articles, the retiring members of the board are Mr. C. W. Benson and Mr. J. Annan Bryce, who, being eligible, offer themselves for re-election. Messrs. Deloitte, Dever, Griffiths and Co. offer themselves for re-election as auditors for the ensuing year."

The meeting will be held at the offices, Norfolk Street, Strand, on Friday, December 12th, at 12.30 o'clock.

Power Gas Corporation.

The report for the period ended September 30th last, submitted at the meeting yesterday, states that the whole of the share capital offered for subscription was applied for and duly

allotted, and the company was authorised to commence business on August 16th, 1901. The company has completed the purchase of the whole of the properties to be acquired in the terms of the prospectus. The shareholders are aware that the purchase included the entire share capital of Ashmore, Benson, Pease & Co., Ltd, of Stockton-on-Tees, where the manufacturing business of the company is carried on. The extension and remodelling of the works was taken in hand at once, and they have now been thoroughly equipped with modern tools and appliances, enabling them to turn out a large amount of work. The expenditure incurred on this account is included under the heading of investments and advances, on the assets side of the balance sheet. The directors announce that contracts for a number of important installations have been secured (including the plant for the South Staffordshire Mond Gas Co.), and that the works are fully employed. The balance-sheet shows a balance to the credit of profit and loss account of £14,967, which the directors propose to apply as follows:—Amount to be written off preliminary expenses account, £2,000; dividend at 6 per cent. per annum upon the ordinary shares, £8,862; dividend at 4 per cent. per annum upon the deferred shares, £2,691; balance to be carried forward to next account, £1,408.

Marconi International Marine Communication Co.

The report of this company for the year ended June 30th last, to be submitted at the meeting on 9th inst., states that during the year the operations of the company have been greatly extended, and many stations are now available for communication with vessels fitted with Marconi apparatus. Orders have also been received from Lloyd's to equip many of their signal stations. An agreement has been entered into with the Canadian Government providing for the equipment and maintenance of wireless telegraph stations on the Canadian coast. Contracts have been secured with the Belgian Government under which one land station and nine of the Belgian mail steamers plying between Ostend and Dover are being equipped with Marconi apparatus. An agreement has also been concluded with the Government of the Congo Free State, in pursuance of which two Marconi stations, one at Banana, in the Congo Free State, and the other at Ambrizette, in the Portuguese Colony of Angola, are now in course of erection. By the adoption, during the past year, of the Marconi system by the American, Allan and Atlantic transport lines, the business of the Atlantic sea telegraph service is virtually assured to this company, and it is confidently anticipated that so soon as arrangements can be made for the erection of land stations at suitable points, those shipping companies owning vessels plying on other routes will avail themselves of the advantages offered by the Marconi system, which have already been proved on the Atlantic route. During the visit of the Colonial Premiers to this country, a demonstration of the practicability and utility of the Marconi system of wireless telegraphy was arranged for them on board the steamer *Koh-i-Noor*. As a result, inquiries have been received from, and proposals submitted to, several of the Colonial Governments.

Metropolitan District Railway Co.—The Preference Shareholders Committee have agreed to advise the holders of £1,500,000 5 per cent. preference shares to accept the proposals of a guaranteed dividend made by the Underground Electric Railways Co. as follows:—1 per cent. from January 1st, 1903, to January 1st, 1904; 2 per cent. from 1904 to 1905; 3 per cent. from 1905 to 1907; and 3½ per cent. thereafter in perpetuity.

British Electric Street Tramways, Ltd.—An extraordinary general meeting of this company was held on Tuesday at the Westminster Palace Hotel. The proceedings were private.

Amazon Telegraph Co.—The meeting of this company was held on Tuesday at the offices, but our representative was not admitted. The directors' report appeared in our last issue.

Western Telegraph Co.—Interim dividend 3s. per share (6 per cent. per annum) for quarter ended September 30th.

STOCKS AND SHARES.

Wednesday Evening.

Irregularity continues to characterise the markets all round the Stock Exchange. Cheerfulness and depression alternate in a remarkably methodical fashion, but business holds aloof. Many think that what is wanted to re-animate the House is a steady rise in Consols, which would react upon all other markets and induce public confidence. Needless to say, the investment departments, such as are those with which we deal, would feel the effect of such a movement to a most satisfactory degree, but the trouble is, that the outlook for any substantial advance in Consols remains decidedly obscure, and must of necessity be so until the New Year. So that, under the circumstances, small mercies and small rises must not be lightly treated, and with the slight hardening of the Funds has come a little better tendency in the investment and electrical divisions.

Notwithstanding the comparative glut of gilt-edged stocks in other sections of the Stock Exchange, the electricity supply prior securities find ready purchasers. In illustration, we may mention that a line of some thousands of Kensington Debenture stock came to market the other day and was easily placed in a very short time. There is no change to record in prices of these gilt-edged varieties; in fact, the monotony of the share list is only varied by an advance of 5s. in London Electric Preference, which are considered a cheap 6 per cent. investment at about 5, their par value.

Within the next 10 days it is expected that the award of the arbitrators in the Marylebone case will be made public, and there is considerable speculation as to how it will "pan out" for the company's shareholders. The Ordinary maintain their ground at 16. St. James's and Pall Mall shares keep dull; a good deal of interest seems to have been aroused by their depression, but in answer to inquiries as to the reason for the fall, the jobbers counterask why Consols and other investment securities are flat. The issue of new Edmundson Preference met with success, and the shares were oversubscribed. A good deal of business is doing in them on the basis of $\frac{1}{16}$ to ⅛ premium over the issue price.

Brush continue their erratic course, the change this week being a rise of 5s. in the price of the Ordinary shares. Electric Constructions are lower to the same extent.

The feeling and animus aroused over certain electrical affairs in Bournemouth have not altered the price of Bournemouth and Poole Electric Supply shares, which are 13 for the Ordinary and 10½ for the Preference. Folkestones are 6¼ and Oxfords 5½, Hoves being 8. Calcutta show a drop of 10s. at £7.

Presentation of private Bills to Parliament has now ceased for a while, but the Bill Office finds itself confronted with an enormous amount of work in connection with light railway schemes. Meanwhile the market for those descriptions which have passed the preliminary ordeals is marking time. In the electric railway group, Central Londons remain somewhat dull, while City and South London fails to recover its late relapse, although the company's traffics are good. Dividend estimates are already in vogue, but since the next four weeks may make a deal of difference to receipts, these guesses, of course, are quite untrustworthy. The "Twopenny Tube" announces that its present locomotives are to give place to the improved motor carriages early next year.

British Electric Tractions have recovered some of their fall, the Ordinary and Preference both being ¼ better. There is no premium on the last-issued lot of Preference shares. Colombo Electric Tramways and Lighting 5 per cent. Debenture stock has been done at 101½ this week. Anglo-Argentine Trams were sold at $4\frac{3}{16}$, and Calcutta Trams are 7¼. Only shareholders were admitted to Tuesday's meeting of the British Electric Street Tramways.

In the Telegraph market Amazon shares have shed a further 10s., and Direct United States Cable shares are down ¼, despite the latter company's announcement as to telegrams being accepted next week for transmission by the new all-British route. Anglo-American Deferred has hardened a fraction on the better tone of the Yankee market, induced by the Presidential message. West India and Panama Telegraph First Preference shares are quoted *ex* 6s. on account of arrears of interest, and the price has been lowered about this sum. There is no recordable change in the Trust Co.'s shares. Great Northerns lost ½ on Mr. Balfour's statement as to the project all-British cable line to India.

National Telephone issues keep good, and the Third Preference are ¼ up at 5. It is said to be growing apparent that the Government competition will not injure the company to any great extent. United River Plate Telephone shares have regained the fraction which was lost last week, it being stated that the strike in Buenos Ayres is at an end.

Accustomed as we are to sensation from the British Westinghouse Electric and Manufacturing Co., this week's report sets forth still more dramatic figures of the success that has attended the concern during the past 18 months. The orders received for the year ending July 31st, 1899, came to £279,000, and those for the four months ending last Monday, were nearly four times as great as the 1899 total. An additional issue of 200,000 5 per cent. Preference shares is to be proposed to the meeting next Friday, December 12th, and we may whisper that if this scheme should be sanctioned, the present shareholders will probably receive the first offer of the shares at a price which is likely to give them a profit. The present Preference are 6½, and the Ordinary about 7. But of course nothing can be known definitely until after the proprietors have agreed to the issue. The Nernst Electric Light report tells of a net loss of £1,643 for the year. Retrenchments are spoken of, and the directors express a hope that the company may soon be in a position to cover expenses. Certainly the board cannot be accused of undue optimism.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Nov. 28th.	Closing Quotations Dec. 3rd.	Business done week ended Dec. 3rd, 1902. Highest	Lowest.
67.100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25 000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	3 — 4	2½— 3½	..	..
119.700	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788.840	Anglo-American Telegraph	Stock	7¾6	3½%	6¼s.	49 — 52	49 — 52	..	..
3.105.5s0	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	93 — 95	93 — 95	94½	93½
3,105.5s0	Do. do. do. Deferred	Stock	£1 7s.	5s.	2s.	8½ — 8¾	8½ — 9	8½	8½
44.000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	5 %	4 — 4½	4 — 4½	..	..
18 333 300‡	Commercial Cable	$100	8 %	8 %	8 %	178 —188	178 —188	..	..
1,841.209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	94 — 96	94 — 96	95½	..
16.000	Cuba Telegraph	10	7 %	4½%	4 %	5 — 6	5 — 6	..	..
6.000	Do. 10 % Pref.	10	..	..	..	12½ — 13½	12½ — 13½	..	..
12.931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½ — 3½	2½ — 3½	..	..
6.000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
60.710	Direct United States Cable	20	3½%	3½%	3½%	10½ — 11	10½ — 10⅝	10 5/16	10½
96.300	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
4,000.000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	128 —128	128 —128	124½	123½
1.955.565	Do. 3½ % Pref. Stock	100	..	..	..	89 — 92	89 — 92	91⅛	89½
1,534.645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	104 —107	104 —107	..	..
800.000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11½— 11⅝	11½— 12½	11⅜	11½
820.000	Do. 4 % Deb. Stock	Stock	..	..	..	107 —110	107 —110	..	..
500.000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8.000, red. 1909	100	5⅛%	..	..	99 —102	99 —102	100	99½
200.000	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102 %	99 —102	..	..
180.227	Globe Telegraph and Trust	10	5⅛%	5½%	5½%	9½— 9⅝	9½— 9⅝	9 7/8	..
180.042	Do. do. 6 % Pref.	10	..	..	..	13 — 13½	13 — 13½	13⅜	13⅛
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	15 %	27 — 28	26½— 27½	..	..
70.000	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —108	100 —108	..	..
17.000	Indo-European Telegraph	25	10 %	10 %	10 %	39 — 43	39 — 43	..	..
100.000	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	101 —105	101 —105	..	..
72.680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72.680	1	2½%	..	..	⅛— ¼	⅛— ¼	..	..
86.492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	..	..	½— 1	½— 1	..	..
1.9-8,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	92 — 94	92 — 94	93½	92
1,966.667	Do. do. Def. Stock	100	..	60	64 xd	62 — 64	62 — 64	63½	62
15.000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12½— 13½	12½— 13½	12½	..
15.000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11½— 12½	11½— 12½	..	..
250 000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	4½— 5⅛	5 — 5½	5⅛	..
2,000 000/	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	95 — 98	..	..
600.000	Do. do. 4 % Deb. Stock Red.	100	..	4 %	4 %	101 —105	101 —105	..	..
171.504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	5 %	6 %	6 %	½— 1	½— 1	..	..
100.000	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	99 —102	99 —102	..	..
11.>89	Reuter's	8	5 %	5 %	5 %	6½— 7½	6½— 7½	..	..
3 303	Submarine Cables Trust	Cert.	..	..	..	110 —120	110 —120	112½	..
58.000	United River Plate Telephone	5	7 %	7 %	7 %	4⅜— 5¼	5 — 5¼	..	..
40.000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½— 5	4½— 5	..	..
179 947/	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15.609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30.008	West Coast of America, Nos. 1 to 30.000 and 53.001 to 53.008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150.000/	Do. do. 4% Debs., 1 to 1.500 guar. by Braz. Sub. Tel.	100	..	..	..	98 —101	98 —101	..	..
207.930	Western Telegraph, Ltd., Nos. 1 to 207.930	10	7 %	7 %	7 %	11½— 12	11½— 12	11 11/16	11½
75.000/	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	102 —105	102 —105	..	..
400 000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	99 —102	99 —102	..	..
88.321	West India and Panama Telegraph	10	3%	3%	..	⅝— ⅞	⅝— ⅞	..	..
31.563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	5 — 5½	5 — 5½	..	..
4.669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3 — 4	3 — 4	..	..
80,000/	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	100 —103	100 103	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20.000	British Aluminium 7 % Cum. Pref.	10	..	5½%	..	3 — 4	3 — 4	..	..
300.000/	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	..	..
100.000	British Electric Traction	10	8 %	9 %	9 %	12½ — 12⅝	12½ — 13	12⅝	12½
100.000	Do. do. 6 % Cum. Pref.	10	..	..	..	1 3/4 — 12½	12 — 1 1/4	12 3/4	12⅜
600.000/	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	123 —126	123 —126	125½	124⅝
100,000	British Insulated Wire Ord.	5	20 %	15 %	10 %	7½— 8	7½— 8	..	..
100.000	Do. do. 6 % Cum. Pref.	5	..	..	..	5½— 6	5½— 6	..	..
50.000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	103 —106	103 —106	..	..
50 000	¶Browett, Lindley & Co. (1c09), Ord.	£1	..	8 %	..	12/3 to 13 6	12/6 to 13/6	..	..
50 000	¶ Do. do. 6 % Cum. Pref.	£1	..	6 %	..	16/6 to 17s.	16/6 to 17s.	..	..
105.731	Brush Electrical Engineering, Ord., 1 to 105,731	3	5½%	5 %	Nil	¾— 1¼	1 — 1¼	..	..
150.000	Do. do. Non-cum. 6 % Pref.	3	6 %	6 %	3 %	1 — 1½	1 — 1½	1⅞	..
125.000/	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	100 —103	100 —103	..	..
125.000/	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	94 — 99	93 — 98	..	..
35 000	Callender's Cable Construction shares	5	15 %	15 %	20 %	14 — 15	14 — 15	..	..
40.000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½— 6	5½— 6	..	..
90.000/	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	109 —113	109 —113	..	..
1,860.014	Central London Railway, Ord. Stock	Stock	..	..	4 %	105 —109	105 —108	107⅛	106⅝
491.093	Do. do. 4 % Pref. Stock	Stock	..	..	4 %	106 —102	105 —108	106⅛	106
491.993	Do. do. Def. do.	Stock	..	..	4 %	106 —109	106 —109	107	..
1,330.000	City and South London Railway	Stock	1½%	1½%	2 %	75 — 76	75 — 76	76	74½
85.000	Crompton & Co., Nos. 1 to 85.000	3	7½%	8 %	7½%	2½— 3	2½— 3	..	..
100.000/	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11.000 of £50 red.	..	..	..	..	101 —106 %	101 —106 %	..	..
99 261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	6 %	2½%	..	⅛— ¼	⅛— ¼	..	..
17.139	Do. do. "A" shares, 01—017,139	5	6 %	2½%	..	1⅝— 2⅛	1⅝— 2⅛	..	..
814.028/	Do. do. 4 % Deb. Stock Red.	100	..	..	..	74 — 78	74 — 78	..	..
100.000	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82	77 — 82	..	..
112.100	Electric Construction, 1 to 112.100	2	6 %	6 %	6 %	1¼— 1⅜	1¼— 1⅜	..	..
31 300	Do. do. 7 % Cum. Pref., 1 to 31.300	2	..	..	..	2⅛— 2⅜	2⅛— 2⅜	..	..
1-2.500/	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
25.000	General Electric Co. (1900), 5 % Cum. Pref.	10	..	5 %	5 %	10 — 10⅛	10 — 10⅛	..	..
200.000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102	99 —102	..	..
85.000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	16½— 17½	16½— 17½	..	..
85,000	Do. do. 4½ % Pref.	5	4½%	4½%	..	5⅛— 5⅜	5⅛— 5⅜	..	..
48.050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	109 —113	109 —113	..	..
50.000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	20½— 21½	20½— 21½	..	..
800.000/	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37.500	Liverpool Overhead Railway, Ord.	10	3½%	3½%	1½%	6⅝— 6¾	6⅝— 6¾	..	..
10.000	Do. do. Pref. £10 paid	10	5 %	..	..	9½— 10⅛	9½— 10⅛	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14½— 15⅜	14½— 15⅜	..	..
	Rosling & Fynn 6 % Cum. Pref.	£1	..	6 %	..	19/0 to 20/0	..	..	..
37.350	Telegraph Construction and Maintenance	12	15 %	17½%	20 %	37 — 40	37 — 40	39⅜	39
150.000	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	102 —103	102 —103	..	..
540,000	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3 %	93 — 96	93 — 96	94	..

† Quotations on Liverpool Stock Exchange.
§ From Bradford Share List.

‡ Unless otherwise stated all shares are fully paid.
¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅛—⅜.
National Electric Prod Wiring, ¾—1.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 13—14.
Do. do. Pref. (£10 pd.), 10—11.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1900.	1901.	Closing Quotations Nov. 26th.	Closing Quotations Dec. 3rd.	Business done week ended Dec. 3rd, 1902. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	£ ‡ 1	..	..	..	⅛ — ¼	⅛ — ¼	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	..	..	..	110 —113	110 —113	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	5	6 %	6 %	8 %	10⅛— 10⅜	10⅛— 10⅜	10⅛	..
20,000	Do. do. 7 % Cum. Pref.	5	..	..	..	10⅛— 10⅜	10⅛— 10⅜	10⅛	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9 — 9⅛	9 — 9⅛	..	..
70,000	Do. do. do. 4½% Cum. Pref.	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4⅜— 5⅛	4⅜— 5⅛	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	105 —107	105 —107	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	6 %	5½%	4 %	5⅛— 6	5⅛— 6	5⅛	..
150,000£	Do. do. % Deb. Stock Red.	Stock	..	..	..	110 —113	110 —113	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	4 %	0 %	5 %	10 — 11	10 — 11	10⅛	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	..	13 — 14	13 — 14	..	..
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	124 —129	124 —129	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	103 —106	103 —106	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4 %	8½— 9½	8½— 9½	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	..	11⅜— 12⅜	11⅜— 12⅜	..	..
400,000£	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red	..	..	..	..	109 —112	109 —112	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	6 %	7 %	7 %	6 — 6⅛	6 — 6⅛	6⅛	6⅛
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6⅛	6 — 6⅛	6	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock	100	..	..	..	107 —110	107 —110	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	11 %	12 %	10 %	10 — 11	10 — 11	..	..
90,000	Do. do. do. 4 % Debenture Stock	Stock	..	..	..	101 —104	101 —104	..	..
110,000	ondon Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅞— 2⅛	1⅞— 2⅛	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	4⅞— 5⅛	5 — 5⅛	..	..
250,000£	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	96 — 99	96 — 99	98⅜	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	5 %	6 %	6½%	15⅞— 16⅛	15⅞— 16⅛	15⅞	..
220,000£	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —114	109 —114	..	..
250,000£	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	99 —102	99 —102	..	..
10,853	Notting Hill Electric Lighting	10	7 %	7 %	6 %	14 — 15	14 — 15	14⅛	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	14⅛	14⅛
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	..	..
150,000£	Do. do. do. 3½% Deb. Stock Red	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	..	1⅞— 2⅛	1⅞— 2⅛	..	..
50,000£	Do. do. 4% Deb.	100	..	..	..	80 — 90	80 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	..	3 — 3⅛	3 — 3⅛	3⅛	..
30,000	Urban Electric Supply, Ord., £4 pd.	5	..	..	..	3⅞— 4⅛	3⅞— 4⅛	..	..
30,000	Do. do. 5 % Cum. Pref., £4 pd.	5	..	..	..	3⅞— 4⅛	3⅞— 4⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	11 — 12	11 — 12	11⅞	11⅞
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6½	6 — 6½	6⅛	6⅛

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, December 3rd.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	42/-	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	£33 10	..
a ,, ,,	per ton	£30	£30	..
a Bleaching powder	per ton	£4 10	£4 10	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£17 10	£19	30s. dec.
a Lead, Nitrate	per ton	£24	£24	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks	per lb.	3d.	3d.	..
a ,, Caustic (75/80%)	per ton	£24	£24	..
a ,, Bisulphate	per ton	£25	£25	..
a Shellac	per cwt.	130/-	130/-	..
a Sulphate of Magnesia	per ton	£4 10	£3 10	..
a Sulphur, Sublimed Flowers	per ton	£6 5	£6 5	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks	per lb.	2¼d.	2¼d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b ,, Wire, in ton lots	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£40 to £130	£40 to £130	..
c Brass (rolled metal 2" to 12") basis	per lb.	5½d.	6½d.	..
c ,, Tube (brazed)	per lb.	8¼d.	8¼d.	..
c ,, ,, (solid drawn)	per lb.	6¾d.	6¾d.	..
c ,, Wire, basis	per lb.	6¼d.	6¼d.	..
c Copper Tubes (brazed)	per lb.	8¾d.	8¾d.	..
c ,, ,, (solid drawn)	per lb.	9d.	9d.	..
g Copper Bars (best selected	per ton	£67	£67	..

METALS, &c. (*continued*).		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£67	£67	..
g ,, Rod	per ton	£67	£67	..
e ,, (Electrolytic) Bars	per ton	£56	£56	..
e ,, ,, Sheets	per ton	£74	£74	..
e ,, ,, Rod	per ton	£63	£63	..
e ,, ,, H.C. Wire	per lb.	7¾d.	7¾d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/4½	1/4½	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/1½ to 3/5	3/2 to 3/5	Dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants)	per ton	51/-	51/7	7d. Dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11	£11	..
g ,, ,, Sheet	per ton	£13	£13	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in original cases) small	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	11½d. to 1/2	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/2	From 1/2	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i Stee., Magnet, acc'd'g to desc'p'n	per ton	£58	£58	..
i ,, ,, in bars		From £15 to £40	From £15 to £40	..
g Tin, Block	per ton	£112 to £113	£112 to £113	..
g ,, Foil	per lb.	1/6	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/6½	1/6½	..
p White Anti-friction Metals—"White Ant" brand	per ton	£36 to £60	£36 to £60	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j ,, 6 lea. Flax	per lb.	5¾d.	5¾d.	..
j ,, 3 ply 10 lbs. Russian	per lb.	4¹¹⁄₁₆d.	4¹¹⁄₁₆d.	..
j ,, 10 lbs. Russian, single	per lb.	4¼d.	4¼d.	..
j ,, 180 lbs. Jute rove	per ton	£11 11	£11 11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23	£23	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons., Ltd. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.P. and Teleg. Works *g* Messrs. James & Shakspeare, [Co., Ltd. *h* Messrs. Edward Till & Co. *i* Messrs. Bolling & Lowe. *j* Messrs. Walter H. Hindley & Co., Ltd.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company Ltd.

TRAFFIC RECEIPTS.

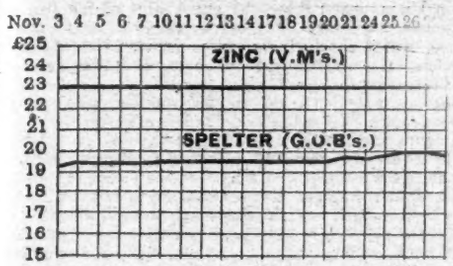
Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
Blackburn Corp. Trys.	Nov. 28	668	+ 51	29,444	+ 3,869	12½	13½
Blackpool and Fleetwood	,, 29	188	+ 17	20,171	— 185	7¾	7¾
Bristol Trys. & Car. Co.	,, 28	4,123	+443	—	—	28	28
British Elec. Trac. Co.:—							
Barnsley	,, 21	170	—	365	—	—	—
Devonport	,, 21	346	— 11	20,132	+ 1,208	5	5
Dudley—Stourbridge	,, 21	728	+140	35,271	+ 4,358	18¾	18¾
Gateshead	,, 21	838	+283	35,568	+ 7,2.6	10½	9¾
Gravesend—Northfleet	,, 21	170	—	3,358	—	3¼	—
Greenock—Pt. Glasgow	,, 21	419	+ 76	23,426	+13,229	7¼	7¼
Hartlepool	,, 21	211	+-20	11,840	+ 1,151	6¾	4¾
Kidderminster	,, 21	98	+ 4	5,808	+ 52	4¼	4¼
Merthyr	,, 21	154	— 27	9,321	— 1,679	3	3
Middleton	,, 21	234	—	10,174	—	8½	—
Oldham—Ashton	,, 21	511	+ 87	24,926	+ 1,471	8	8
Poole	,, 21	196	+ 18	12,145	— 32	3¾	3¾
Potteries	,, 21	1,710	+385	70,114	+ 4,362	28¾	28¾
Rothesay	,, 21	39	+ 14	1,510	+ 588	—	—

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
B.E.T. Co. (*continued*)—							
Southport	Nov. 21	222	+116	12,107	+ 1,584	5¾	5¾
South Staffordshire	,, 21	618	— 66	35,984	— 1,136	21¾	22¼
Swansea	,, 21	440	+ 52	22,169	+ 1,456	5¾	5¾
Taunton	,, 21	40	— 9	3 029	— 345	1¾	—
Tynemouth	,, 21	247	+ 51	13,886	+ 1,951	3¾	3¾
Weston-super-Mare	,, 19	37	—	5,463	—	2¾	—
Wolverhampton Dist.	,, 21	300	+197	10,143	+ 6,594	10¾	2¾
Central London Railway	,, 29	7,094	+230	145,870	+11,571	6	6
City and S. London Ry.	,, 30	3,677	+415	67,027	+21,089	6¼	6¼
Doncaster Corp. Trys.	—	—	—	—	—	5¾	—
Dover Corporation Trys.	,, 29	168	— 2	10,504	+ 47	8	8
Dublin United Trys.	,, 28	4,2?0	+345	105,883	+ 2,?83	46	46
East Ham Tramways	,, 29	416	+115	11,690	+ 2,388	5	4¾
Glasgow Corp. Trys.	,, 15	12,678	+2,227	204,762	—11,445	57¾	48
Liverpool Overhead Ry.	,, 30	1,445	+ 9	34,318	— 668	6¾	6¾
Newcastle Corp. Trys.	,, 29	2,967	—	—	—	35	—
Sunderland Corp. Trys.	,, 30	980	+ 38	41,679	+ 2,798	17¾	17½

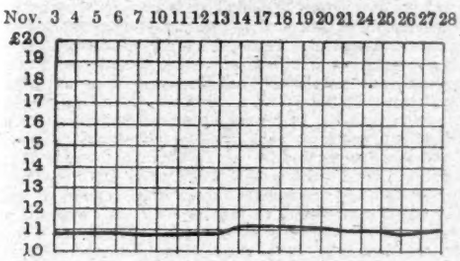
* Compared with the corresponding period of 1901.

METAL MARKET.

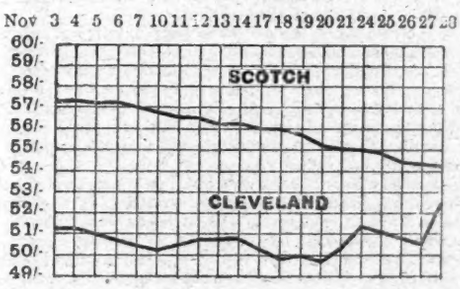
Fluctuations in November.



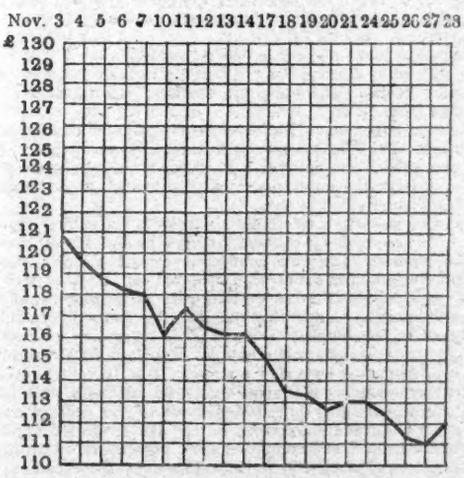
LEAD (ENGLISH).



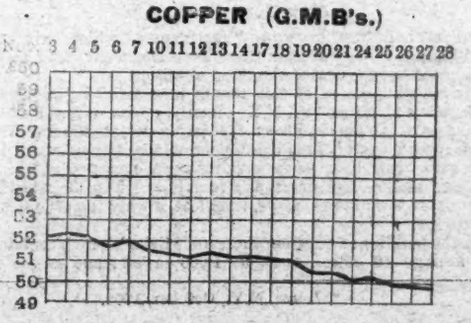
IRON.



TIN.



COPPER (G.M.B's.)



THE MANCHESTER ELECTRICITY UNDERTAKING.

Questions having arisen in the City Council with regard to the policy of the Electricity Committee, particularly as to expenditure on plant—which is alleged to be in excess of the requirements—the matter has been referred to an expert, with instructions to report fully. As soon as the report has been received, it will be presented to the Council and published. Meanwhile, some figures showing the magnitude of the works and their gradual development may be interesting.

The application to the Board of Trade for the original lighting order was made in 1890, and the sanction of the Board was given on July 17th, 1892. The scheme, then, was for a loan of £80,000, repayable over 25 years. Following upon this application, however, were 10 others promoted in quick succession, and in conjunction with the various authorities in Greater Manchester, including the populous districts of Levenshulme, Moss Side, Withington, Droylsden, Heaton Norris, Audenshaw and Denton. They are as follow:—October, 1893, £70,000; May, 1895, £100,000; August, 1896, £100,000; August, 1897, £125,458; March, 1898, £15,053; September, 1899, £181,610; November, 1899, £22,000; August, 1900, £189,890; June, 1901, £810,110; and March, 1902, £477,000—making the total amount of loans sanctioned £2,171,121. In addition to these, a further amount of £75,000 was asked for in the last Manchester Corporation Bill. Electric lighting orders were granted, contemporaneously with these loans, to the suburban districts, with power to transfer them to the Corporation. At the expiration of the period specified in each case, the various authorities have the option of taking over such part of the undertaking as lies within their several districts, but in the meantime the obligation to supply current for lighting over these districts, roughly estimated at 22 square miles, rests with the Manchester Corporation. For some years the Manchester undertaking turned out the largest municipal electric supply outside London; and though for the present its lamp connections are exceeded by those of Glasgow and Edinburgh, and its output and extent of capital outlay by that of Liverpool, it is probable that in a couple of years, when the enterprise has been completed, the city will again take the foremost place among provincial municipalities. For some years the development of the business was hampered by the difficulty experienced in maintaining a generating capacity proportionate to the demand for electricity. So late as 1901 the Electricity Committee had to refuse 60,000 8-c.p. lamp connections, on account of the inadequacy of the plant to produce the power required. It was, therefore, considered prudent to look ahead and provide plant sufficient to meet the estimated needs up to 1904, for both tramways and lighting. The capital expenditure on land, works, railways, battery stations, sub-stations, cables, meters, instruments, stores, and the consulting engineer's remuneration had, up to March 31st, 1902, amounted to £1,164,307, of which £301,014 was laid out in the year 1901-2. Some idea of the relative cost of the individual parts of the work may be gathered from the following figures:—

Dickinson Street	£238,699
Bloom Street	145,115
Stuart Street	50,965
Stuart Street railway	9,732
Hunt's Bank battery station	6,634
Sub-stations in Manchester and outside districts	29,936
Cables	596,056
Meters	42,446
Instruments, stores, &c.	44,724
	£1,164,307

Analysed in another way, the figures show that, in capital expenditure, the generating stations have cost £449,511; the distributing stations, £39,972; cable stores, £29,362; mains, £596,055; meters, £42,446; instruments, £4,822; and office furniture, £2,136. Comparing it with other large municipal undertakings, the following figures show Manchester's present position:—

	No. of lamps.	Units sold.	Load in kilowatts.	Capital expenditure.
Liverpool	361,980	20,018,142	9,431	£1,187,622
Glasgow	491 306	9,282,043	7,950	962,727
Edinburgh ...	465,125	7,760,307	6,007	765,512
Manchester ...	414,115	10,502,299	9,140	1,164,307

The large number of units sold by Liverpool, as compared with the number of lamp connections, is accounted for by the tramway demand, the whole scheme being now completed. In the case of Edinburgh, two factors have combined to bring about the profit of £10,295 on an undertaking which supplies an area only one-sixth of that catered for by the Manchester Corporation. These are, first, the gradual increase in the number of customers, owing to the familiarity with the advantages of electric lighting, and, significantly enough, the drop in the price of energy from 3·01d. to 2·96d. to private consumers, with a corresponding increase in public consumers, leaving the combined price as before. The latest figures for the Manchester district show that in 1901-2 the number of consumers was 4,030, the number of lamps in use 414,115, and the number of motors 774. The supply to a section of the tramways was started in June, 1901, and on the present records this class of business is only accountable for 19 per cent. of the output, as against 81 per cent. for general supply. But, in its effect on the load factor, its good

influence is already traceable. By slight economies in all but one of the items the expenditure has been reduced by 0·12d per unit sold, and this in spite of the high prices of coal. The last year's working has, too, been beneficial in Manchester by raising the charges per unit by ¼d. This produced an additional revenue of £11,500, and is assured a balance of £7,635 on the right side, or more than double that of the previous year. During the eight years of the existence of the Manchester undertaking it has contributed £52,964 in relief of the city rates, has redeemed £32,857 of its original loan capital, and has built up a small reserve fund of £16,341. In the load in kilowatts and number of units sold, the city will probably be ahead of the other municipalities above named when its tramway system is completed. It is estimated that the tramways will then require 19 million units per annum. The capital expenditure must necessarily increase in proportion owing to the large area of supply, and the measures to be taken to overcome the difficulties connected with long-distance supplies. This has required the erection of no fewer than 19 sub-stations. The Tramways Committee promises within six months from the present time to have 638 cars running, and by the end of next year, allowing for the routes yet to be opened and cross routes, 119 more, or 757 in all. The Electricity Committee has shown itself to be well abreast of these and other needs.

NOTES ON RECENT AMERICAN INSTALLATIONS.

By FRANK BROADBENT, M.I.E.E.

The Peruna Drug Manufacturing Co., Columbus, O.*

This installation embraces the manufacturing and shipping departments of the above company, the Hartman Building, the Hartman Sanitarium and Hospital, and the various shops and stores which occupy the ground floor of the above buildings. In all there are connected 2,600 lamps of 16 c.p., 130 enclosed 220 volt arcs, and motors aggregating 130 B.H.P. Included in the latter are 85 desk and ceiling fans for use during the summer months.

The small fan industry is a much bigger thing in America than here; in fact, most of the portable fans used in this country are imported. Owing to our climatic conditions, the load factor of a fan motor must be very low indeed, but it might be improved by the addition of the heating attachment, when the fan could be used in winter time. This heater takes the form of a resistance strip, wound spirally and fixed in front of the fan blades. When the fan is in motion, warm air is caused to circulate, and a more even temperature may be maintained in a room than is possible by any other method of heating.

The most usual method of heating large buildings in America is by steam, and steam heating generally forms an important adjunct to isolated electrical installations.

In the installation under notice, a certain amount of live steam, and the whole of the exhaust steam, after passing through a heater, are used for heating purposes, the heating pipes having a total surface of about 32,000 sq. ft.; the condensed water is then returned to the boilers by means of a duplicate set of direct-acting vacuum pumps. Feed water is also obtainable from several other sources. In the first place, there are underground cisterns provided under the large buildings for the storage of rain water. The combined capacity of these is upwards of 70,000 cubic ft. Then there is a roof tank, which receives all waste water in the building, fed by means of an automatically controlled pump; and, lastly, there is the town supply. The underground cisterns ensure a very soft feed for considerable periods.

A Reed marine-type oil filter, and Worthington hot-water meter, are placed in the main feed pipe, both being fitted with bye-pass connections.

The generating plants, three in number, one of 150 KW., and two of 75 KW. output each, are typical of American practice for small sets, consisting of horizontal engines coupled direct to multipolar dynamos. The latter are of Siemens & Halske 250-volt type, with brushes on the periphery of the armature. Semi-circular pits under the machines afford access to the lower brushes.

The switchboard occupies a corner of the engine room, the centre panel being placed across the corner, and the side panels making an angle of 90° with each other. This, from the point of view of the attendant, is a very convenient arrangement, as he can see or handle any instrument or switch from one position. The panels do not divide the poles, as is customary in English practice, and as required by the "tariff" fire offices. There are three generator panels, each fitted with the necessary D.P. switch and instruments for one machine, and two feeder panels, one containing 29 lighting feeder switches, and the other 14 power feeder switches. These switches are of the cheap D.P. knife pattern, rarely used over here for main switchboard work.

Each dynamo panel is provided with a change-over switch for connection either to the lighting or power bus-bars. A coupling switch on the centre panel permits of the two sets of bars being joined together, so that during periods of light load one machine can supply both light and power.

The voltmeter switch is provided with contacts, which permit of the potential between line and earth being measured, and a table fixed below the voltmeter gives the values in megohms corresponding to the various readings. This is a little addition to a board which does not cost much, but is a very useful guide to the electrician-in-charge, and is worthy of more general adoption. Earth lamps are all very well as a rough indication, but the earth test through a voltmeter shows the exact value of the line insulation within certain limits. Another useful addition to this board is a framed record sheet giving switch number, size of fuse wire, size of cable, safe-carrying capacity, length of feeder, and location of distribution box for each feeder.

The wiring throughout is on the 220-volt two-wire system, the maximum drop in voltage to the lamps being 2½ per cent.; a more sensible figure than the 1 and 2-volt limit imposed in this country. The wires are all run in conduits, electrically connected and earthed, and not more than three bends are permitted in one run of conduit, without a straight waybox. Three bends are certainly quite enough to pull wires through; as for withdrawing a wire, this, from a tube containing three or four conductors, is almost impossible, even with only one bend in the tube, unless the latter be amply large in diameter.

A great point is made of the neatness of the wiring, and a photograph of a distributing cabinet is intended to illustrate this. The illustration is not a happy one, and it is certain that no leading insurance company in this country would pass the jumbled mass of wires shown in this print. There is simply no attempt at either neatness or regularity.

Throughout the installation all the conductors are stranded, which conforms with the best English practice, and none having a smaller section than No. 14 is used, except in fittings. Each circuit from a distributing box or cabinet is provided with a D.P. knife switch, and asbestos-covered fuses. In English practice the separation of the poles, involving the fixing of positive switches and fuses on one slab, and the negative on another, renders it difficult, or at any rate, inconvenient, to use D.P. switches for small branch circuits; using the term "D.P. switch" in its literal sense to mean a switch which acts on both poles simultaneously. Unless the switches on opposite conductors are locked together, there is no advantage in providing them, as one only is used regularly, and, for testing purposes, it is an easy matter to disconnect the fuses, more particularly if these are of the clip type.

In the applications of the motors to machine driving, and in the lighting arrangements, there is nothing in this installation calling for special mention, as there are no radical departures from everyday practice; on the other hand it is noteworthy that the elevators are not electrically but hydraulically driven. They are fed by a compression tank, placed in the basement, served by an automatically-controlled Worthington duplex compound steam pump. The elevator speed is 350 ft. per minute.

There is a very complete telephone system throughout the buildings, carried out on the central battery system. In the works 36 telephones are used, connected with a 50-way switchboard, from which trunk connections are taken to a 200-way desk pattern switchboard in the Hartman building, serving 165 instruments. The switchboard, which is of the lamp signal pattern, is also connected with the local telephone exchange. Any who has visited the London P.O. exchange will have been struck with the remarkable silence of operation with this system as compared with the older systems. A motor-generator is used for the ringing circuits, and a storage battery for talking.

A somewhat novel feature is the supersession of the ordinary factory whistle by electric buzzers, placed in the offices, and in all the factory rooms. The whole are operated simultaneously from the engine room clock.

The medical department has a very complete and comprehensive installation. For Röntgen ray work, and also for the direct application of electricity to patients, a 10 plate, 30-in. influence machine is used. A large insulated platform is provided, upon which 10 patients may be treated at once.

In continuous current treatment a patient is not subjected to the full line pressure by being connected across the mains in series with a resistance; but a resistance is connected across the mains, and the patient is connected in shunt with such portion of it as will give the requisite pressure for the desired current to pass through his body or the part to be operated on. By this method very delicate adjustment of the current is possible. For cautery operations a rotary and static transformer are used. Tappings off the secondary winding of the static permit of a range of 0 to 10 volts in 50 steps. An auxiliary secondary coil gives 4 volts for use with examination lamps, this circuit being quite independent of the cautery circuits. Many other features are described in the article referred to, such as the preparation of, and compression of, chemically pure oxygen, the application of electricity in the bath rooms, &c., features appealing to the specialist rather than to the general reader.

* *Electrical World and Engineer*, N.Y., April 26th.

A New York Skyscraper.*

The tall buildings, known as "skyscrapers," which have reached their highest development in New York, have advanced with, and are limited by, the uses of electrical elevators.

The record erection of this nature is situated at the junction of Park Row and Broadway, N.Y., directly opposite the Post Office, and has a total height above the pavement of 390 ft. Without quick speed elevators such buildings would be impossible of habitation, as it would be a day's work for anyone occupying the upper floors to ascend and descend a few times. The electrical equipment of such buildings plays, therefore, a very important part in the design.

In the building in question there are 31 stories, each containing on the average 40 offices, or about 1,200 in all; and as the frame-

* *Power*, N.Y., October, 1902.

work is of steel, the design of this, together with the heating, laundry, fire, refrigerating and electrical equipment, is practically a matter of engineering rather than of architecture. The steam heating of a building of this size (and this is the usual method) is no small matter, and as a large boiler plant is necessary, with a staff of stokers and engineers, the only extra expense involved for generating electrical energy is for coal and water and the interest and depreciation on the generating plant, the exhaust steam from which passes into the heating service. In other words, there is little or no expense for boiler plant or labour. Under these conditions, the owner of the building can supply electricity to his tenants at a considerably lower cost than the public supply company can do it.

In the building under consideration the steam raising plant consists of three B.W. boilers, each of 300 H.P., designed for a w.p. of 140 lbs. per sq. in. Buckwheat anthracite is used in the furnaces, burning under natural draught, which is sufficiently powerful owing to the great height of the chimney, which is, of course, carried to the top of the building. The generating plants are of the stereotyped character, viz., horizontal engines coupled directly to multipolar dynamos. There are four sets in all, two of 200 KW., one of 100 KW, and one of 75 KW. English practice tends to uniformity in the sizes of the generators on private installations for the sake of interchangeability of spare parts, but it is often worth considering whether or not the annual cost of interest and depreciation on a spare armature or so is not less than the annual loss due to running a large plant on light load for a great portion of the year. In large office buildings of this nature, in which the elevator load is a great item, the variation of load is very considerable, the maximum load occurring when all lights are on and the elevators are in full operation. This is late in the afternoon, when the clerks are all rushing to catch trains. After that the load falls off rapidly, and during the night is very small, when it is taken care of by a storage battery. The latter has a capacity of 2,000 ampere-hours.

As the exhaust steam is used for heating during five months of the year, the advantages of condensing are not great, whilst there are many disadvantages. Condensed water from the refrigerators in summer, and from the heaters in winter, is pumped back into the boilers, after passing through a heater and a charcoal filter.

The working voltage is low—viz., 120 at the generators—involving very heavy mains and switchboard connections. All four dynamos feed into the centre of the main board, the distributing panels being arranged on each side—power circuits on one side and lighting on the other. Any of the dynamos can be connected through a booster with the battery, and the latter can be connected up in parallel with the generators, to assist them during periods of heavy load. Each circuit is provided with a D.P. switch of the knife pattern, both poles being on the same slate. The back connections are very simple, heavy bus-bar being supported in porcelain channels held by cast-iron brackets bolted to the iron frame. Each bracket is stepped to take both positive and negative bars, which are arranged one above the other, but not in the same vertical plane. Connections are made to the switches by bolts passing through the bars, secured apparently by nuts on both sides of the bar.

In all there are 10 elevators of the Sprague high-speed type. The controllers are fixed in the basement, but no further particulars are given beyond the statement that "the delicacy of control is really wonderful."

There are upwards of 10,000 lamps of 16 C.P. fixed throughout the building, averaging about 260 on each floor. The effect of the peculiar climatic conditions obtaining in N.Y. upon the load factor of the electrical plant is well exemplified in this installation; the refrigerating and fanning in summer and the lighting in winter all tending to level up the load and to keep down the works cost per unit. As a matter of fact, the load on the generators is very little more in winter than in summer.

THE CONTROL OF TRAFFIC ON ELECTRIC TRAMWAYS.

Some reflections by a writer who signs himself as Dr. Karl S., in a recent issue of the *Neue Freie Presse*, of Vienna, are sufficiently interesting to deserve the attention of British students of electric traction, and we therefore present the article to our readers in a somewhat condensed form.

The most important economic advantage of street railways (in common with any other kind of railway), the author reminds us, lies in the speed of conveyance. In consequence, speed is one of the chief requirements of the traffic organisation. But this demand must be satisfied without going to such lengths as to jeopardise the primary consideration, namely, that of safety. While, however, speed should always be subordinated to safety, this does not imply that one of the main advantages which the provision of an electric street railway offers a community, namely, the guarantee of more expeditious locomotion, is made illusory, and that the rate of driving has to be again brought down to that of the common vehicle.

It was pointed out recently that, to-day, it is only necessary to keep time between one stopping place and another, while no definite maximum speed is insisted upon, and in case of delays, therefore, the rate after the obstructions have been disposed of may be increased at pleasure to make up for the loss in time. If this is not exactly the case, still a very sound principle underlies the statement; as is the practice on the national railways, a minimum time must be fixed for each line, which may be employed in the case of delays occurring. The normal time will therefore be based upon a speed somewhat less than the maximum velocity. Though this apparently puts a restriction upon the free development of the traffic, such procedure is very advantageous in the case of street railways as it enables delays to be made up for which would be impossible were the time fixed so that no shortening were admissible, or in other words, were the regulation speed identical with the tabulated speed.

It is necessary, furthermore, not to simply fix an arbitrary quantity as the maximum speed applicable to all cases, but to decide upon it after careful consideration of local requirements, thus creating several groups of greatest speeds. Apart from the fact that at the present time different motormen drive with different speeds over the same road and under the same circumstances, it may frequently be observed that at places where, in the estimation of the onlooker, running at the very lowest rate would appear the only reasonable course—for instance, where the track is laid in close proximity to the footpath—the speed is not even reduced.

Of great importance to safe travelling are the alarm signals. The primary object of these signals is to obviate accidents by warning people in danger of being run down. A short reflection, however, will show that the alarm does not fulfil its mission, if the driver is only under obligation to give it when there is danger in sight, because there are instances where the danger is only brought home to him when it is too late to avert a disaster. We are, consequently, thrown upon the contention that as long as the electric car does not have the whole roadway to itself, the alarm bell should be rung continuously for the benefit of pedestrians and vehicles interested in the use of the road. From this point of view the suggestion, which has been made in public more than once, that bells should be provided, sounded automatically by the movement of the car, cannot lightly be disposed of. The effect of this alarm might be increased by means of a bell-mouth, through which device it would be attained that only the persons concerned would really, and very distinctly, hear the signal, besides which any mistake as to the direction of the car giving the alarm would be made impossible.

These warning signals deserve particular attention in the case of two passing trains or cars. The danger—especially great in heavily trafficked thoroughfares—of a fatal encounter with another car, after a person has crossed the track just vacated by one going in the opposite direction has, indeed, been taken account of and greatly minimised by laying the tracks as far apart as possible, *i.e.*, on each side of the road, close to the side-walks. By this arrangement it has also been possible to dispense with any special provision of refuges, which, besides their unquestionable advantage, also possess the drawback of acting as obstructions to other classes of traffic. Now, in order to effectively meet the danger associated with passing cars, it should be incumbent upon the drivers, where automatic alarm is not adopted, to sound the bell continuously from the moment that the cars are still 10 metres apart, until they are well clear of one another. At present the practical adoption of this very important principle seems to be left to the initiative of individual drivers.

The constantly increasing importance of street railways as a common means of conveyance lends plausibility to the suggestion that tramways may ultimately obtain sole right to the use of their tracks. This would mean that both horse-drawn vehicles and pedestrians were permitted to cross the rails only at certain fixed points, which might be advertised by strips of special paving, and also through suitable signs (illuminated at night). Such an innovation would, it is true, entail the necessity of a partial reconstruction of the roadway, but, in return, the traffic would be handled with much greater ease and rapidity.

In the above, the special principles that should govern the traffic on electric tramways have been hinted at. For the rest, it may be said that the organisation of traffic on electrically-driven street railways should be accomplished on much the same lines as our experience with ordinary railways has proved expedient. It would not be desirable to lose ourselves in much detail, but some brief considerations as to the succession of cars or trains cannot be omitted. This question is closely related to a third requirement—besides those of speed and safety—namely, the adjustment of the traffic facilities to the actual needs, or, in other words, the introduction and upholding of a time schedule equal to the existing traffic demands. How far the street railways of to-day meet this requirement will not be examined here, although a considerable amount of interesting material is at disposal. Now, while for the purpose of meeting the actual requirements, the quickest possible succession of cars would appear desirable, the regard for safety will put a certain restraint upon too rapid circulation for the sake of avoiding both accidents to persons and collisions of cars. It is possible to mathematically fix a minimum limit to the intervals between cars, the shortest permissible interval being made up of the longest normal stoppage of a train or car at any station on the route, and the time it takes to move so far away from the stopping place as to make room for the succeeding car. If the cars are put into motion at shorter intervals, the result will be, as may be frequently observed, that prematurely despatched cars will have to wait and form obstructions outside the stopping places. It is true that the proper order and succession cannot always be maintained, and it will therefore be desirable to regulate the traffic at certain points, particularly at crossings, by correcting the intervals, and re-establishing the smooth running of the cars. The increase in *personnel* necessitated thereby may be justified even on strictly economical grounds.

An engineer has recently suggested the use of quite short cars. This, however, would only allow of a quicker succession, while the safety of driving would, in no wise be enhanced, but rather the

opposite. In order to cope with an equal amount of traffic, more cars would be required, and briefer intervals would result in consequence; but to the latter, considerations of safety have imposed a definite limit. The fact that short and light cars may be brought to a standstill in a shorter space of time cannot, of course, be denied, but more perfect braking contrivances may be confidently looked forward to, whereby the advantage of light cars in this respect would be practically nullified. The suggestion, however, might be altered to a general recommendation of economy in the matter of length by a thoughtful utilisation of the space available, without going to quite short cars.

It is not quite apparent, on weighing the above considerations, that the frequent accidents on our electric tramways constitute a necessary evil, or that they are due solely to the want of caution on the part of pedestrians. Such caution may, indeed, be absent in cases, but even then it is not the only cause of the disaster. The evil is more deeply rooted, and lies in the want of systematic organisation which still characterises our present electric street railways. Most of the proposals, shooting up like mushrooms, both from technical men and laymen, are a struggle against the symptom, rather than the disease itself. It is not sufficient to create a masterpiece; it is no less necessary to know how to control and handle the new thing, so that it may accomplish its object to the full.

LONG-DISTANCE POWER TRANSMISSION IN FRANCE.

One of the most important long-distance electric power transmission plants lately completed on the Continent is that known as the Usine Hydro-Electrique de Saint-Georges in the Aude Department of France, belonging to the Société Meridionale de Transport de Force. The station, which is intended to supply electrical energy from a single power station to all parts of the Department, was carried out by the Société d'Application Industrielle. The power station is located at St. Georges; the water is taken from the River Aude by means of a masonry dam or weir, 131 ft. long, provided with two discharge sluices. The derivation canal for a distance of nearly 4½ miles is mostly underground, while for about a mile it consists of a conduit of armoured concrete, built on the mountain side. The subterranean canal is almost rectangular in section, its dimensions being 6½ ft. by 6½ ft., with a uniform fall of 16 in 10,000. The conduit terminates in a chamber from which extend two pipes along which the water is forced. The pipes are 40 in. in diameter, and can convey 1,600 litres of water per sec. at a speed of 6½ ft. per second; their total length is 524 ft. At about 40 ft. from the power station, each of the two pipes is divided into two smaller ones, each feeding one turbine.

The power station has been designed to receive eight sets of turbines and dynamos; at present four are installed and at work. The turbines, which were constructed at Les Ateliers de Vevey (Switzerland), are of the Pelton type. Each is fitted with an automatic speed regulator, which has proved satisfactory in practice, variations in load of 50 per cent. not resulting in variations of speed of more than 4 per cent. Each turbine is directly connected by means of a flexible coupling, acting as the fly-wheel, to an Alioth alternator, requiring 800 H.P., and developing 700 KV.-A. The terminal pressure is 2,900 volts at a speed of 300 revolutions per minute. The exciters are mounted on the ends of the alternator shafts; the exciting current at 50 to 60 volts being 25 amperes. At full load the alternators have an efficiency of 93 per cent. From the generators the current passes to the fusible circuit breakers, and thence to the switchboard, which contains a separate panel for each machine. All the four alternators may be grouped in parallel without much difficulty. From the switchboard the current passes, at 2,900 volts pressure, to the transformers which raise it to 20,000 volts. The latter are of the Alioth single-phase type, arranged in a group of three; each has a capacity of 200 KW., so that they form a three-phase group of 600 KW. Special attention has been given to the ventilation of the room in which they are located. The high-pressure current is transmitted to a switchboard in a special room. The various switches, &c., on this are not operated directly by hand, but at a distance, through the medium of compressed air.

In such a power-transmission plant as this, it may be said that it is the high-pressure feeder which forms the delicate part, requiring special attention. The feeder conductor is 43¾ miles long. The loss of power on the line has been estimated at 20 per cent. as a maximum, when the power developed at the station reaches 1,620 KW., taking the power factor as 80 per cent. The feeder consists of three cables, 3·8 mm. diameter, formed in an equilateral triangle, the distance between them being 60 centimetres. The supports are 32 ft. high, and are located at intervals of 131 ft. The cables are supported on triple-bell insulators, tested up to 40,000 volts. The whole system of distribution depending on this feeder, great care was given to its insulation, while, in order to ensure keeping it in good condition, a watchman has been stationed at every 6½ miles to look after his section. Each watchman's box is in telephonic communication with the power station. Any necessary repairs are carried out on Sundays, between 2 a.m. and 3 p.m., during which period no current is transmitted.

The central distributing station is at Fabrezan, 42¾ miles from the power plant. Secondary stations are located at Narbonne and Carcassonne; the pressure of the lines is 17,000 volts, and each of the villages supplied with current is provided with a transformer station, in which the pressure is reduced to 130 volts.

The distributing system, according to the *Revue Pratique de l'Electricité*, at present extends to over 250 miles, and when finished will reach 375 miles. It will, therefore, be seen that special arrangements had to be made to ensure its successful operation. To this end an exhaustive scheme has been devised, a copy of which has been furnished to each responsible agent. In this the duties of each are specifically defined, and rules given as to what has to be done in case of accident, so that the interruption of the current shall be of as short a duration as possible. The staff is under the control of an engineer in-chief, who has under him a chief of the system, resident at the main distributing station at Fabrezan. This official has under his charge 19 miles of the feeder, which is laid, not along the highway, but through a hilly country much exposed to the wind, eight watchmen being told off to assist him in his work. Two sub-chiefs, with watchmen, take care of the feeder where it leaves the power station, while the sub-stations at Carcassonne and Narbonne have each a chief engineer responsible for the work in their districts.

The plant is worked on somewhat new lines; the local authorities of the villages supplied with current are charged with the cost of installing the secondary conductors: in return for this, however, the power company contracts to furnish electricity for public lighting free of charge on the basis of 25 16-C.P. lamps per 1,000 inhabitants. While some private lighting is done, the bulk of the power is utilised in operating water-lifting pumps, ice factories, breweries, &c. Financially the undertaking has already proved a success, and among French engineers it is considered that the good results achieved, from the technical point of view, bring a step nearer the day when power plants will be located not only near available water-power, but close to the collieries, distributing the current generated to any desired distance.

SOME CONTINENTAL CARBIDE FACTORIES.

Although the combined capacity of the numerous plants already laid down throughout Europe for the manufacture of calcium carbide so far exceeds the consumption that a second syndicate of makers has had to be formed—after the brief and unsatisfactory existence of the first had come to an end—in order to control the output, yet there are several projects under consideration for the erection of fresh works. Apparently the cause of this curious phenomenon is the action of the syndicate itself, which has ordered some of the older factories to be closed and others to work only half time or less; so that, having limited the production of carbide to somewhere about the dimensions of the demand, a high price—pleasant for the manufacturers, but distinctly unpleasant to the consumers—is capable of being maintained. Accordingly, numerous persons interested in the consumption of carbide, and better acquainted, perhaps, with the combustion of acetylene than with the preparation of carbide, have thought to place non-union material on the markets at a price, they hope, lower than that imposed by the ring. They have been encouraged in this idea by the approaching import tax on calcium carbide in the German Empire, which will affect the syndicate somewhat, because many of the factories are outside the German fiscal boundaries, though worked with German capital; for which reason a factory located inside the frontiers will have an advantage in freedom from tax, over and above that of lower freights whenever it finds itself near an acetylene consumer of sufficient magnitude. At the present time a Berlin firm is engaged in erecting a carbide factory in the district of Steinbech, near to the river Drage, and practically on the Oder also. A waterfall on the Drage, capable of yielding 1,400 H.P., has already been "harnessed" by another Berlin concern, and the work is said to have been performed so cheaply, that, added to the natural advantages of the locality, where the watershed extends for 1,935 sq. kilóm., power can be obtained for less than 30 m. per H.P.-year, a figure which includes the cost of the ground, houses, and gardens for the men and officials of the station. In the carbide factory the generators and furnaces are being supplied by the Allgemeine Elektricitäts Gesellschaft, of Berlin, and the subsidiary plant by Stadler, and it is hoped that work will be begun early next year. The situation of the factory has been advantageously chosen, because lime, coke, and electrodes can be delivered cheaply by water carriage over the Oder, while it is also in a part of Germany, between Berlin and Stettin, where several towns are already provided with central acetylene installations. In fact, carbide can be sent to Strelitz, Treptow, and Grimmen, three of the most important of these village customers, for a little over 1 mark per ton by railway. It remains to be seen whether the enterprise will prove successful; probably it will, especially after the import duty has been finally imposed; but one single 1,000 H.P. works will scarcely be able to lower the price of syndicate carbide by its competition in the markets. In Berlin, by the way, the syndicate price is now 28.00 to 28 50 marks. Many of the north-west German consumers of acetylene are buying American carbide, some 750 metric tons having been imported during three months of the past summer.

A carbide factory erected some little time ago at Hömekoski, in Finland, has been compelled to abandon the manufacture, and to take up that of caustic soda. This works was forced to use wood charcoal in its electric furnaces, because the English coke which it had

tried to import *viâ* Wiborg proved too costly. It was also doing an export trade only, and consequently had to pay duty on all its make, since until 1904 Finland is outside the custom boundaries of Russia. In Russia itself there is now only one small factory running, situated at Zcomkowice, near Warsaw, which employs steam power, for another works at Siitola, burnt down some months back, is not going to be rebuilt.

INSTITUTION OF ELECTRICAL ENGINEERS.

Dublin Section.

A meeting of this section, was held in the Royal College of Science, Dublin, on November 21st Mr. Tatlow, hon. sec., said that the section numbered 61 members. Since their last meeting they had lost their chairman (Mr. J. W. Towle), and their hon. sec. (Mr. Frank Gill), both of whom had left Dublin to take up valuable appointments in London. Mr. Arthur Porte, their vice-chairman, had been elected chairman of the section; and Prof. W. E Thrift, vice-chairman for the present session.

Prof. Barrett, who presided, said that few societies had in one session sustained so great a loss as their section had owing to the removal to London of their chairman and their hon. sec. However, they all rejoiced that those two distinguished members had been offered and appointed to very high and responsible positions, and they were glad to think that to fill the positions of chief electrical engineer of the Metropolitan Railway, and of the National Telephone Co., of England, it was necessary to come over to Ireland to get the suitable and efficient men required.

Mr. Porte then took the chair. He thanked his professional brethren for the honour conferred on him in placing him in the position of chairman of their section. In congratulating Mr. Towle on his appointment, they should also congratulate their colleague, Mr. Percy Sheardown on being promoted to the position lately occupied by Mr. Towle. The chairman then spoke in complimentary terms of Mr. Gill, who had been appointed chief engineer of the National Telephone Co. They could not allow Mr. Gill to sever his connection with their section without marking the occasion, and accordingly they arranged to present him with a piece of silver plate. Mr. Porte then proceeded with his address.

The presentation to Mr. Gill was subsequently made by the chairman.

Prof. Barrett said that when Mr. Gill accepted the position in London, Mr. Tatlow kindly took up the duties of hon. sec., and he had admirably discharged them.

NOTES ON THE TESTING OF TRAMWAY MOTORS, AND AN INVESTIGATION INTO THEIR CHARACTERISTIC PROPERTIES.

By Michael B. Field, Member, A.M.Inst.C.E.

(Paper read at Glasgow, May 13th, 1902.)

(*Concluded from page* 919.)

In conclusion, I will merely add a few approximate formulæ for calculating the time-intervals corresponding to given current ranges, which are convenient if one desires to determine roughly the curves shown in figs. 18 and 19, by calculation.

The formulæ are based on the assumption that $\frac{n}{E}$ can be represented by the expression $\alpha + \beta c$ (see Note 2). This will be found to be very nearly correct for up-to-date tramway motors over a considerable range. It cannot, of course, be pushed too far, but the formulæ here given must be used with discretion, the values of α and β being determined for each type of motor considered.

Let V = supply voltage.
$c_1\ c_2$ = higher and lower limits of current range (total current).
$E_1\ E_2$ = the back E.M.Fs. of motor with currents c_1 and c_2 at speed n.
r = total resistance in circuit.
T = mean effective tractive effort, or retarding effort producing acceleration, either positive or negative as case may be, corresponding to range $c_1 - c_2$.
ω = acceleration.
$n_1\ n_2$ = initial and final speeds corresponding to c_1 and c_2.

Then in case of applying the electric brakes—

$$n_1 = r\left(\alpha + \frac{\beta c_1}{2}\right)$$

$$n_2 = r\left(\alpha + \frac{\beta c_2}{2}\right)$$

$$n_1 - n_2 = \frac{r\beta(c_1 - c_2)}{2} \qquad (1)$$

$$\text{time-interval} = \frac{r\beta(c_1 - c_2)}{2\omega}. \qquad (2)$$

* N.B.—In fig. 10 current *per motor* is plotted with *total* resistance; we are here dealing with *total* current and *total* resistance.

In the case of acceleration—

$$\left.\begin{aligned}\frac{n}{2E_1}(V - c_1 r)\\ \frac{n}{2E_2}(V - c_2 r)\end{aligned}\right\} = \text{initial and final speeds, motors in series.}$$

$$\left.\begin{aligned}\frac{n}{E_1}(V - c_1 r)\\ \frac{n}{E_2}(V - c_2 r)\end{aligned}\right\} = \text{“ “ “ “ “ “ parallel.}$$

But $\frac{2nc_1}{E_1} = \alpha + \beta c_1$ and $\frac{2nc_2}{E_2} = \alpha + \beta c_2$, motors in series;

also $\frac{nc_1}{E_1} = \alpha + \frac{\beta c_1}{2}$ and $\frac{nc_2}{E_2} = \alpha + \frac{\beta c_1}{2}$ “ “ parallel.

Hence—

$$n_1 - n_2 = (c_1 - c_2)\left\{\frac{V\alpha}{4c_1c_2} + \frac{\beta r}{4}\right\} \text{ motors in series.} \quad (3)$$

$$n_1 - n_2 = (c_1 - c_2)\left\{\frac{V\alpha}{c_1c_2} + \frac{\beta r}{2}\right\} \text{ “ “ parallel.} \quad (4)$$

And the time-intervals in the two cases are expressed by—

$$\frac{c_1 - c_2}{\omega}\left\{\frac{V\alpha}{4c_1c_2} + \frac{\beta r}{4}\right\} \qquad (5)$$

$$\frac{c_1 - c_2}{\omega}\left\{\frac{V\alpha}{c_1c_2} + \frac{\beta r}{2}\right\} \qquad (6)$$

In the case of the 12-ton car before referred to, using the values 0·554 and 0·0237 for α and β respectively, we can write:—

Braking—

$$n_1 - n_2 = 0{\cdot}0118\, r\,(c_1 - c_2);$$

$$\text{time interval} = 8{\cdot}03\ r\ \frac{(c_1 - c_2)}{T}.$$

Acceleration—

(5) becomes $\frac{(c_1 - c_2)}{0{\cdot}00147\,T}\left\{\frac{69{\cdot}2}{c_1c_2} + 0{\cdot}0059\,r\right\}$.

(6) “ $\frac{c_1 - c_2}{0{\cdot}00147\,T}\left\{\frac{277}{c_1c_2} + 0{\cdot}0118\,r\right\}$.

TABLE XI.—*Rapid Acceleration on level.*

Notch.	Time seconds.	Initial current.	Final current.	Mean current.	Current consumption.	Initial velocity.	Final velocity.	Mean velocity.	Distance covered. Feet.
No. 1 Series	1·5	56	30	43	64·5	0	1·95	·98	2·15
No. 2 “	0·5	50	40	45	22·5	1·95	2·8	2·38	1·75
No. 3 “	0·5	56	40	48	24·0	2·8	3·6	3·20	2·35
No. 4 “	10·0	50	14·5	19·9	199·0	3·6	7·1	6·05	88·70
No. 1 Parallel	0·5	51	49·4	50·2	25·1	7·1	7·35	7·23	5·30
No. 2 “	0·5	71	64	67·4	33·7	7·35	7·85	7·60	5·57
No. 3 “	20·0	110	29	40	800·0	7·85	15·0	12·90	378·0
Totals...	33·5				1,168·8				483·82

Slow Acceleration on level.

No. 1 Series	10	56	16	23·8	238·0	0	5·1	3·56	53·5
No. 2 “	5	19·5	16·5	18·0	90·0	5·1	5·8	5·5	40·3
No. 3 “	5	18	16	17·1	85·1	5·8	6·5	6·2	45·5
No. 4 “	5	16·7	15·5	16·1	80·5	6·5	6·8	6·7	49·0
No. 1 Parallel	10	53·2	34·4	43·8	438·0	6·8	10·4	8·2	120·1
No. 2 “	5	43	35·0	39·0	195·0	10·4	11·9	11·2	82·1
No. 3 “	5	41	34	37·6	188·0	11·9	13·6	12·8	93·5
Totals...	45				1,314·5				484

TABLE XII.—*Rapid Acceleration on 4·5 per cent. up gradient.*

Notch.	Time seconds.	Initial current.	Final current.	Mean current.	Current consumption.	Initial velocity.	Final velocity.	Mean velocity.	Distance covered. Feet.
No. 1 Series	2·0	56	40	48	96·0	0	1·3	·7	2·05
No. 2 “	1·0	65	45	55	55·0	1·3	2·5	1·9	2·79
No. 3 “	1·0	65	45	55	55·0	2·5	3·3	2·9	4·25
No. 4 “	5·0	55	33·5	40	200·0	3·3	4·4	4·1	20·45
No. 1 Parallel	2·3	75	71	73	299·0	4·4	4·8	4·6	16·20
No. 2 “	3·0	130	76	100	300·0	4·8	7·2	6·0	26·40
No. 3 “	16·0	130	67	72	1,152·0	7·2	9·4	9·1	215·00
Totals...	30·3				2,157·0				287·14

Slow Acceleration on 4·5 per cent. up gradient.

No. 1 Series	10	56	33	36	360·0	0	2·1	1·7	24·5
No. 2 “	5	52	34	43	215·0	2·1	3·3	2·7	19·8
No. 3 “	5	45	33	39	195·0	3·3	4·0	3·7	27·1
No. 4 “	5	40	33	36·5	182·5	4·0	4·4	4·2	30·8
No. 1 Parallel	10	75	68	71·4	714·0	4·4	5·2	4·8	70·4
No. 2 “	5	120	70	83·0	415·0	5·2	7·6	6·8	49·8
No. 3 “	5	110	80	95·0	475·0	7·6	9·2	8·8	645
Totals...	45				2,556·5				286·9

Table XIII. (here omitted) gives a comparison of a few values, calculated from the above formulæ, with the correct values. I have now to acknowledge my indebtedness to Mr. G. Braid for the help he has given me in the preparation of the various tables and figures included in this paper. I further wish to mention that the results of actual tests have been given, not so much on account of the information they contain in themselves, as to exemplify the methods of testing and investigation of which the paper treats.

NOTES.

Note 1.—For a given field strength, we may take the total iron and friction loss as $(H + f)n + Fn^2$, where H, f, and F represent the losses at the speed $n = 1$ due to hysteresis, friction and windage, and Foucault currents respectively. Dividing this loss by n we should then obtain a linear relation between speed and $\frac{\text{loss}}{n}$, from which the value of $(H + f)$ and F can be easily determined. The writer has, however, not carried out this refinement in the case in question.

Note 2.—It is interesting to note that the $\frac{n}{E}$ and current curve is very nearly a straight line throughout the range shown. If we write

$$\frac{n}{E} = \alpha + \beta C,$$

and $$\frac{n}{E} = \zeta \frac{C}{F},$$

F being the total armature flux or if we assume ζ includes a certain coefficient of magnetic leakage, we may say F = mean flux throughout the magnetic circuit. Now F is of the nature of an induction $\times$ an area or $B \times A$. Let B stand for a mean effective induction, such that we can say total field magnet ampere-turns $\propto \frac{B}{\mu}$, μ being of the nature of a mean effective permeability for the circuit. A will be an area equal to $\frac{F}{B}$.

We have then $C \propto \frac{B}{\mu}$, which leads to the expression $\mu = \frac{\lambda - B}{\rho}$; α, β, ζ, λ, ρ being unknown constants. This form of expression for μ for iron circuits is well known; Dr. S. P. Thompson gives in his short article on dynamos in Munro and Jamieson's Pocket-Book, $\mu = \frac{17000 - B}{35}$ as being approximately correct between 6,000 and 16,000 lines per sq. cm.

The linear relation of $\frac{n}{E}$ to C in motors of the type in question is of such interest that the author has shown in fig. 10A the ampere $-\frac{n}{E}$ curve for motor Q together with the mean calculated values of induction per sq cm. in different portions of the magnetic circuit, plotted with reference to current. It will be observed that inductions as high as 26,000 are indicated, while the maximum induction in the teeth under the leading horns probably reaches over 30,000 lines per sq cm. The values of α and β for motor P are ·554 and ·0237, and for motor Q ·56 and ·0244 respectively.

Note 3.—If a sufficiently small time interval be taken during which one may assume that the tractive effort, or retarding effort, as the case may be, decreases uniformly, the total change of velocity during that time-interval is exactly equal to the mean acceleration multiplied by the time, but the distance traversed is *not* equal to one-half the mean acceleration multiplied by the square of the time, but to one-third of the maximum plus one-sixth of the minimum acceleration, multiplied by the square of the time.

In other words, if a represents acceleration,

a_0 a_1 represent the initial and final values of a taken over the time interval t_1,
k = rate of change of acceleration,
t = time in seconds,
t_1 = length of time-interval,
v = velocity,
v_0 v_1 = initial and final velocities taken over time-interval t_1,
s = distance traversed,
S = total distance traversed in t_1.

We have the following relations:—

$$a = a_0 - k t$$

$$a_1 = a_0 - k t_1$$

$$\text{Hence } v = v_0 + a_0 t - \frac{k t^2}{2}$$

$$\text{And } v_1 = v_0 + a_0 t_1 - \frac{k t_1^2}{2} = v_0 + \frac{a_0 + a_1}{2} t$$

$$\text{Or } v_1 - v_0 = \frac{a_0 + a_1}{2} t$$

$$\text{Further } s = v_0 t + \frac{a_0 t^2}{2} - \frac{k t^3}{6}$$

$$\therefore S = v_0 t_1 + \left(\frac{a_0}{3} + \frac{a_1}{6}\right) t^2.$$

If $a_0 - a_1$ be a sufficiently small quantity in comparison with a_1, or if $\frac{a_0 t}{2}$ is small compared with v_0, we may write $\frac{a_0 + a_1}{4}$ for $\frac{a_0}{3} + \frac{a_1}{6}$, i.e., we may calculate the distance traversed from the mean acceleration.

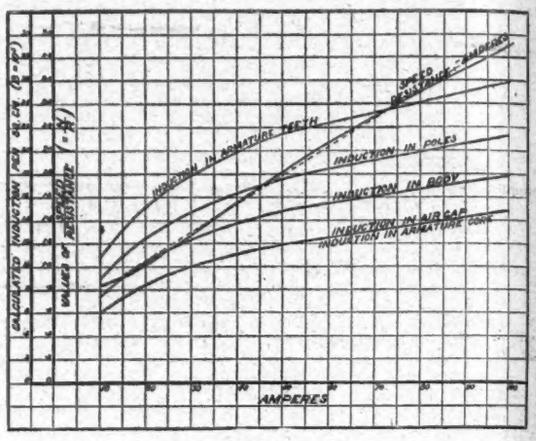


FIG. 10A.

It would be incorrect, however, to assume that the retarding force decreases uniformly throughout large ranges. The subsequent diagrams show that this is not the case.

Note 4.—Extract from *Electrical World and Engineer*, December 16th, 1899:—"Mr. Charles Hewitt, engineer of the Union Traction Company, of Philadelphia, contributed a brief paper under the title of 'The Motorman as an Element of Street Railway Economy.' Tests were made by him by placing a wattmeter on a car without the knowledge of the motorman, and then having that car run on a number of routes by a number of different motormen. . . . The results showed that the number of passengers carried had an almost inappreciable effect on the watt-hours per car-mile, and that the variations in the amount of energy consumed depended almost entirely on the motorman. The watt-hours per car-mile varied very greatly for different motormen, but were nearly constant for the same motorman. They indicated that the usual test of a motor made in this way is really a test of the motorman. Omitting extremes, the saving of all motormen who were as good as the best, amounted to 43 per cent. The results showed what an important factor the motorman really is in the amount of power consumed by the cars, and how important it is to properly instruct the motormen in the most economical use of the controller."

Shortly after the inauguration of electric traction on the Springburn route in Glasgow, wattmeter readings were taken with different drivers, and variations from 800 to 1,080 watt-hours per car-mile were observed under conditions as nearly equal as possible.

In February, 1893, car-wattmeters were installed on all the cars of the Nashville Street Railway Company, in America, with the result that a reduction of 39 per cent. of the power consumed was effected within the first three months. This system possesses such physical features as give the greatest scope for the skill of a motorman to come into play. In level towns such reductions cannot, of course, be expected.

THE DESIGN OF CONTINUOUS CURRENT DYNAMOS.

By HENRY A. MAVOR, Chairman of the Glasgow Local Section

(Paper read at Glasgow, November 11th, 1902.)

(*Concluded from page* 920.)

A REFERENCE to the formulæ in the Appendix will show how the values of these losses have been determined. The losses in the core are seen to depend upon its weight, the core induction and the periodicity of magnetic reversal. See Appendix (1).

It is convenient to find expressions deriving the core induction from the induction in the air space, and this is contained in a formula given in Appendix (1).

A high value of the induction keeps down the quantity of material in the active belt, the number of turns of wire required, and the resistance voltage. On the other hand, the induction in the air space is limited by the necessity for mechanical clearance and by the size of the armature. The author has not gone into the investigation of the highest permissible value of the induction in

the air space. This maximum will be found to depend with any given form of magnet on the relation between the length of the path through the magnet and the space available for wire.

It is now almost universal to demand a fixed brush position for all loads, and therefore it is of the highest importance that the values of the induction in the air space and teeth should be kept as high as practicable.

The range of speed variation by shunt regulation depends on the reduction of the field strength, so that it is advantageous on this ground also to have the initial strength as high as possible.

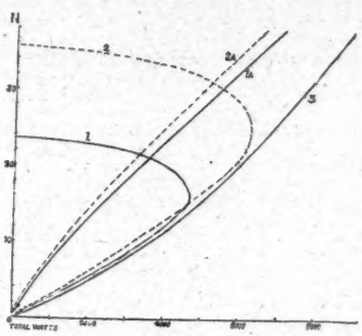


Fig. 1.

It will be seen that the value of the core loss is not susceptible of any very great variation, that a reduction in the quantity of material with consequent increase in the induction does not materially affect the loss in the core. We therefore turn to A_{II} and A_{III} as the quantities susceptible of the most effective change.

A_{II} and A_{III} are seen to depend upon the weight of the teeth. Here, again, it is convenient to derive this weight directly from the

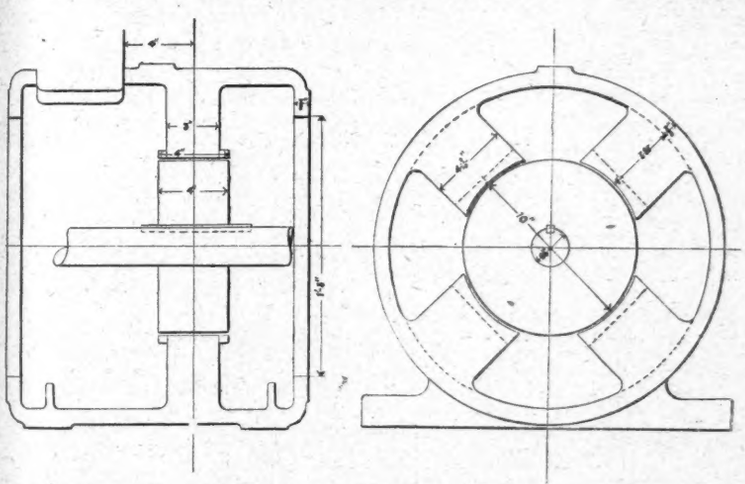


Fig. 2.

slot depth, and a formula has been arranged and given in Appendix (1), deriving the dimensions of tooth and slot from the slot depth, the induction in the air space and the maximum induction in the teeth. The factor which is susceptible of the most effective variation is the slot depth, and diagrams showing the effect of the variation of the slot depth take the form shown in fig. 1, which is worked out for a machine of 10 in. diameter.

The value of the induction in the teeth, though susceptible of considerable variation, cannot be reduced so as to materially affect the result. Considerations of commutation call for a high value of the tooth induction as well as of the induction in the air space, so as to provide a "stiff" field and to throttle or minimise cross induction and consequent shifting of the diameter of commutation with change of load.

The limit of the tooth induction appears to be fixed by the risk of leakage of the field into the slot, causing eddy currents in the conductor. The values of the induction in the air space which appear to be adopted in current practice, and as indicated in the paper by Prof. Silvanus Thompson already referred to, appear to be not very far from the value chosen in the Congress paper, viz., about 6,000 to 8,500 lines per centimetre.

The value of the tooth induction commonly adopted is a maximum of 20,000 to 22,000 lines per centimetre. Speaking generally, the changes which can be made have the following effect:—

Increase of core induction, slot depth, air space induction, and tooth induction all have the same effect upon the output curve of the machine as increase in speed, and increase in slot depth produces by far the most conspicuous change.

The iron losses decreasing with decrease in slot depth, a point is reached when the slot becomes too shallow to hold the wire, and a limit is reached in this direction. If the wire be outside the slot the risk of eddy current loss must be taken into account.

Turning now to the value $A\sqrt{n}$, the radiation factor is susceptible of some variation. The demand for enclosed motors, which we may say in passing does not seem to have any good theoretical justification, but like so many demands which have become common, and which have been accepted by the designers of machines without sufficient consideration or resistance to outside influence, appears to be entirely injurious—this requirement of enclosure of the motor, which prevents circulation of air, and thus prevents the armature from getting rid of its heat to the moving air, restricts the output of the machine quite unnecessarily. Under certain circumstances it is necessary to protect the motor from moisture, but the most injurious kind of dust which can lodge on an armature is the dust from the commutator and brushes. A good hard commutator and high quality of carbon brush make very little dust, but a certain amount of wear on the carbon brush is unavoidable, and the carbon dust is a conductor, whereas most of the dust floating in the atmosphere consists of oxides, silicates, and other non-conducting matter.

Artificial methods of ventilating the motor shell are possible, and in cases where the motor must be protected from damp may be found useful, but the best way of procuring a circulation of air is, where it is possible, to expose the motor freely to the atmosphere. Ventilation of the cores of small machines is an expensive, and on very small machines an impracticable, expedient.

Turning now to the question of efficiency, this may be considered from the points of view of use of material and of conversion of energy. Taking the use of material first, if we insert the value now given for w, the total watts of the machine, in the value of K (see Appendix 3), we get—

$$K = \text{ergs per second per cubic centimetre per second} \times 10^7 = \frac{\sqrt{A_{III}}\, Q\, s_r \times 10^{-5}}{\pi d s \times \sqrt{2L + D\,7{\cdot}44}{P}}$$

which brings out very clearly the importance of the cross sectional area of the copper on the machine. $Q\,s_r$ is this factor.

The energy per cubic centimetre of the active belt is proportional to the square root of this value, and inversely proportional to the square root of the length of each turn and to the depth of the slot.

The author has for some time been using the method of consideration first published, so far as he is aware, by Mr. Henry M. Hobart in his paper in *Traction and Transmission* in October, 1902, in which he lays great stress upon the importance of a high value for the cross-sectional area of copper in the active belt ($Q\,s_r$).

While admitting to the full the truth of Mr. Hobart's remarks on this point, it must not be forgotten that the insulation of armature conductors has to be considered as a question of mechanical clearance and protection as well as of specific insulation, so that it is conceivable that a high value of Q would result in greater risk of breakdown from the armature conductors coming into contact with one another in handling. This is a point which can only be settled by experience, and the arguments used in favour of multiple coverings on cables apply with still greater force to armatures, *i.e.*, that a covering in many layers of a lower specific insulation is better than a covering of one layer of higher specific insulation. This accounts for the practice of covering armature conductors with several layers of tape, and, in addition, insulating the slot itself by means of paper, or binding paper to the conductors themselves. The use of a comparatively thick layer of paper is much more effective and safer than of a thinner layer of mica, which, though of a much higher insulating property, is much more liable to mechanical damage.

The efficiency of conversion of energy is the ratio between—

$$\frac{\text{Total watts generated less watts lost in machine}}{\text{Total watts generated plus watts lost in iron}} = \frac{W - A_{III}n}{W + A_r\sqrt{n} - A_{III}n}.$$

Here, again, the importance of keeping down the iron loss is clearly brought out, and the accompanying diagrams show the great importance of this factor in a small machine.

Fig. 1 is to summarise the argument of this paper. It contains five curves, and has reference to a machine, the carcase of which is shown in longitudinal and in cross-section in fig. 2. Fig. 1, curve 1, represents the total watts generated in the armature, which is 25·4 centimetres in diameter, 10·16 centimetres long, with a slot depth of about 2·38 centimetres, and was run at a speed of 1,000 revolutions per minute, giving an output of 4,600 watts, with a temperature rise of about 70° F. above the temperature of the surrounding air.

Curve No. 2 represents the total watts generated by a similar armature, with a slot 1·6 centimetres deep, which was run at the same speed, and gave approximately the same output.

Curves Nos. 1A and 2A represent the calculated outputs of two

armatures, respectively with the same windings as 1 and 2 but with no slots, *i.e.*, smooth cores with different depths of winding.

Curve No. 3 is the approximate envelope of all possible curves of output for this carcase. This curve may be slightly varied by variation in the inductions, but within practical limits it is not subject to much variation, and shows the maximum output obtainable from the carcase at all speeds. The magnet winding and air space induction is the same in all the cases.

A study of this diagram will throw considerable light on the problem of estimating the possible output from any carcase, and also upon the probable effect of speed of rotation on the output of any given machine carcase. It will be evident that as the iron losses become less important, as they do in the larger sizes, the envelope will tend to become fuller in form, and as the speed of the larger sizes of machines is limited by the strength of the material, the rate of rotation is reduced, the upper part of the curve becomes of less importance, and the lower part of the curve approaches more and more nearly to the straight line, which is consistent with the experience that on the larger sizes the watts generated are nearly directly proportional to the speed of rotation.

Symbols Used in Appendix.

B_a = Induction in air space in C.G.S. lines per centimetre.
B_c = Induction in core, lines per square centimetre.
B_t = Induction in teeth in C.G.S. lines per centimetre.
c = Total current in amperes.
E = Total E.M.F. of armature in volts.
G = Sections in commutator.
d = Diameter of core measured to the middle of the active belt, in centimetres.
d_1 = Internal diameter of core discs in centimetres.
d_2 = Diameter of core to bottom of teeth, in centimetres.
D = Diameter of core overall, in centimetres.
L = Length of core in centimetres.
m = Armature turns per section of commutator.
n = Revolutions per second.
p = Paths through armature.
P = Number of poles in the machine.
Q = $\dfrac{\text{Copper area in slot}}{\text{Area of slot}}$.
s = Depth of slot in centimetres.
S_s = Area in centimetres of 1 slot × number of slots.
x = $\dfrac{\text{Pole surface} \times P}{\pi D L}$.
y = Ratio of $\dfrac{\text{Iron in core}}{\text{Total cubic content of core}}$.

APPENDIX I.

Formulæ and constants for determining core and tooth losses:—

Hysteresis and Eddies in the Core.

$A_I\, n$ = weight of core discs × $B_c^{1.6}$ × periodicity × $3{\cdot}25 \times 10^{-8}$ in lbs.

Weight of core discs = $0168\, y \dfrac{\pi}{4} (d_2^2 - d_1^2)\, L$.

Weight of one cubic cr. of iron = ·0168 lb.

$$B_c = \frac{B_a x \pi D L}{P y (d_2 - d_1)} L.$$

$$\text{Periodicity} = \frac{P n}{2}.$$

Hysteresis in Teeth.

$A_{II}\, n$ = weight of teeth × $B_t^{1.6}$ × periodicity × $1{\cdot}85 \times 10^{-6}$.

Eddies in Teeth.

$A_{III}\, n$ = weight of teeth × $B_t^2 \times \left(\dfrac{P n}{2}\right)^2 \times 3{\cdot}84 \times 10^{-12}$.

Weight of teeth is derived from—

Belt volume = $\pi \left(\dfrac{D}{2}\right)^2 - \pi \left(\dfrac{D - 2s}{2}\right)^2 = \pi s (D - s)$.

Width of tooth at bottom = $\dfrac{B_a x \pi D}{B_t y x} = \dfrac{\pi D B_a}{B_t y}$.

Width of slot = $\pi \left(D - 2s - \dfrac{B_a D}{B_t y}\right)$.

Volume of slots = $S_s L = L \pi s \left(D - 2s - \dfrac{B_a D}{B_t y}\right)$.

Volume of teeth = $L \pi s (D - s) - \left(D - 2s - \dfrac{B_a D}{B_t y}\right) =$

$L \pi s \left(s + \dfrac{B_a D}{B_t y}\right)$.

Weight of teeth = $0168\, y L \pi s \left(s + \dfrac{B_a D}{B_t y}\right)$.

APPENDIX II.

These constants are believed to be reasonably accurate, but they have to be carefully checked by actual results for various types of carcase.

Formulæ and constants for determining radiation from the surface of the core only for a rise of 70° F., above an atmospheric temperature of 70° F.:—

Partially enclosed armatures, without ventilating spaces—

$A v \sqrt{n}$ = watts radiated from core surface
= $\pi D L \times 0073 \times \sqrt{\pi D n}$.

Open machines, armatures, with ventilating spaces—

$A v n = \sqrt{\pi D L} \times 0152 \times \sqrt{\pi D n}$.

Open machines, armatures, without ventilating spaces—

$A v \sqrt{n} = \pi D L \times 01 \times \sqrt{\pi D n}$.

Totally enclosed machines—

$A v \sqrt{n} = \pi D L \times 0073 \times \sqrt{\pi D n}$ for 90° rise.

Formulæ and constants for determining radiation from the whole surface of core and end winding for a rise of 70° F., above an atmospheric temperature of 70° F.:—

Partially enclosed armatures without ventilating spaces—

$$A v \sqrt{n} = \pi D \left(L + \frac{2D}{P}\right) \times 00165 \sqrt{\pi D n}.$$

Open machines, armatures with ventilating spaces—

$$A v \sqrt{n} = \pi D \left(L + \frac{2D}{P}\right) \times 01 \sqrt{\pi D n}.$$

Open machines, armatures without ventilating spaces—

$$A v \sqrt{n} = \pi D \left(L + \frac{2D}{P}\right) \times 008 \sqrt{\pi D n}.$$

Totally enclosed machines—

$$A v \sqrt{n} = \pi D \left(1 + \frac{2D}{P}\right) \times 00565 \sqrt{\pi D n}, \text{ for 90° rise.}$$

APPENDIX III.

Formulæ and constants for determining winding data:—

$$\text{Length of end winding} = \frac{4D}{P} \sqrt{1 + \frac{\pi^2}{4}} = \frac{D\,7{\cdot}44}{P}.$$

$$\text{Length of one turn complete} = 2L + \frac{D\,7{\cdot}44}{P}.$$

$$\text{Resistance of one turn} = \left(2L + \frac{D\,7{\cdot}44}{P}\right) \frac{2 m G}{Q S_s} \times 2 \times 10^{-6}.$$

$$\frac{\text{Copper area}}{\text{Slot area}} = Q, \text{ Area of each conductor} = \frac{Q S_s}{2 m G}.$$

Specific resistance of copper at 130° F. taken at 2×10^{-5}.

$$\text{Weight of copper on armature} = \frac{Q S_s}{2} \left(2L + \frac{D\,7{\cdot}44}{P}\right) 0194.$$

* A_{IIII} = watts lost in winding = $\left(\dfrac{c}{p}\right)^2 \left(2L + \dfrac{D\,7{\cdot}44}{P}\right) \dfrac{2 m G}{Q S v} \times$

$2 \times 10^{-5} \times m G$.

$$\therefore \frac{G m c}{p} = \frac{\sqrt{A_{IIII}} \times \sqrt{Q S v} \times 500}{\sqrt{2L + \dfrac{D\,7{\cdot}44}{P}}},$$

$$\text{and } E C = \frac{G m c}{p} \times \pi D L \times B_a x \times 10^{-8} \times 2 \times n.$$

$$\therefore E C = \frac{\sqrt{A_{IIII}} \times \sqrt{Q S v} \times \pi D L B_a x \times 10^{-5}}{\sqrt{2L + \dfrac{D\,7{\cdot}44}{P}}} = W.$$

$$K = \frac{W}{\pi D L s \times \pi d n \times B_a x} = \frac{\sqrt{A_{IIII}} \times \sqrt{Q s v} \times 10^{-5}}{\pi d s \times \sqrt{2L + \dfrac{D\,7{\cdot}44}{P}}}.$$

* Where the output is calculated from the radiation from core only, substitute $2L + \dfrac{D\,7{\cdot}44}{P}$ in value of A_{IIII} for watts lost in slot winding only.

REVIEWS.

The Electro-Plating and Electro-Refining of Metals. By Alexander Watt and Arnold Philip. Crosby Lockwood & Son. 12s. 6d. net.

This book is really a new edition of Watt's well-known work on "Electro-Deposition," revised and largely re-written by Arnold Philip. It contains 650 pages, and is divided into two parts: Part I. on "Electro-Plating," and Part II. on "Electro-Metallurgy." There is much new matter in Part I. in which the already complete details of the plating of gold, silver, nickel, &c., are made more elaborate and intricate. There is here presented a very large proportion of information which is purely historical and, although no doubt of interest to the patentee, is nevertheless somewhat cumbersome to anyone requiring a rapid reference. Here and there the revising is a little incomplete; thus on page 367 reference is made to the frontispiece as depicting metallo-chromes, whereas it really is a view of the Anaconda depositing room. In this part, too, one is led to believe that aluminium can be deposited from solution, whereas in

Part II. the matter is set right. The second part, which is almost entirely new, is mainly devoted to the discussion of the electrolytic refining of copper, and here, perhaps, may be found the most complete information existing to aid either in the design or management of such a refinery.

The refining of gold and silver bullion, lead and nickel, the treatment of tin, the production of aluminium and electro-galvanising are all ably dealt with, although not so minutely as copper. Altogether the work can be highly recommended to every electro-plater, and is of undoubted interest to every electro-metallurgist.

Municipal Telephony: Should we adopt it? Published for the Ratepayers' League, Tunbridge Wells. Price 6d.

The title asks a question: the book answers it. Those who are familiar with telephonic affairs at Tunbridge Wells will know the answer, but those who, whilst interested in the subject of municipal telephony, have not had the ratepayers' view placed prominently before them, may well invest the small sum required to purchase a copy of this booklet. It is written from a popular standpoint, and need not be shunned by those who fear that the subject is too technical to be studied with advantage by laymen. There are some peculiarities of diction—the use of the word "soprano" as a verb (p. 7) is certainly new to us—and the style generally is of a somewhat exaggerated type. But the author apparently wants to reach the ratepayer, and is perhaps familiar with the best means of doing it. The readers to whom the facts will appeal without extraneous aid can readily skip the settings. Should a second edition be called for, an obvious misprint in the figures on p. 57 will doubtless be corrected.

"Practical Engineer" Electrical Pocket-Book and Diary, 1903. Manchester: The Technical Publishing Co., Ltd. Price 1s.

This is the fourth annual edition, and has been revised and enlarged, articles on conduit systems of wiring, electric lifts, power gas, and the Board of Trade regulations for electric lighting and traction having been added. There is a good index, a large amount of reading matter (over 300 pages), and a quantity of squared paper in the form of a diary at the end. The information given covers a very wide range, including wiring and testing, descriptions of practical instruments, rules and data for the design of electrical and allied machinery, gearing, alternating currents and machinery, power required to drive machinery, lighting, traction, mining and electrolysis. Some small errors have been noticed, as, for instance, "milli-ampere," on p. 17, for "micro-ampere," the use of the term "100-millionth" for "one hundred-millionth" (p. 21), "induction" for "inductance," &c. It is rarely, indeed, that we find work and power correctly defined; why is this confusion so prevalent? In this case, fortunately, we have observed only one such error—namely, "1 watt = about 44¼ foot-lbs.," the indispensable time element having been omitted. The description of the Aron meter on p. 80 refers to an obsolete type. On p. 106 we are told that cast-steel has only been adopted to a "limited extent" in dynamo construction.

The classical data for the permeability of wrought and cast-iron published by Dr. John Hopkinson in 1885 still figure on pp. 93 and 108; when will it be discovered by the compilers of pocket-books that these data are totally inapplicable to modern brands?

The value of punctuation and correction in proof may be estimated from a startling statement on p. 178; we read that when a transformer is left on open circuit, "the primary current is very nearly in quadrature with the impressed volts; and, if it were not for hysteresis eddy-currents in the core would be practically watt-less." On p. 183, power factor is defined as "the ratio of 'true watts' to volt-amperes (or the cosine of the angle of lag) at full load." The last 11 words should be omitted, or qualified. The singular determination of the compositor to spell Benardos with a superfluous "r" appears, as usual, on p. 258. We wonder why "silicon" is spelt "silicium" on p. 271.

In spite of minor faults, however, this book certainly contains a great deal of useful and practical information, and is worthy of a place on the engineer's desk or beside his drawing board.

"Practical Engineer" Pocket-Book, 1903. Manchester: The Technical Publishing Co., Ltd. Price 1s.

This familiar pocket-book has been greatly enlarged; indeed, it is now quite a fat little handful, having 568 pages of reading matter, in addition to a quantity of squared paper and a good index. The editor draws attention to the practice in many drawing offices of figuring drawings in both inches and millimetres—a long step towards the adoption of the metric system—to facilitate which an excellent set of conversion tables has been added. Other additions have been made in various sections. It is interesting to note, as evidence of the advance of technical training, the comparatively large space devoted to temperature-entropy diagrams and their practical applications.

It is unnecessary to dwell on the many useful features of such a well-known handbook; suffice it to say that it is full of information, handy tables, &c., for the use of the practical engineer.

Fowler's Mechanical Engineer's Pocket Book, 1903. By W. H. Fowler. Manchester: The Scientific Publishing Co. Price 1s. 6d.

This useful annual has again been revised and enlarged. The recent developments in connection with steam and gas engines have received special attention. There is a small section on electrical units which appears to be generally accurate; the only error which we have noticed is in the explanation of the use of negative indices on p. 279. We have on previous occasions referred to the completeness of the index; this is justified by the enormous amount of practical information contained in the book, in the briefest form, rendering it a most valuable companion to the engineer.

"Mechanical World" Pocket Diary and Year Book, 1903. Manchester: Emmott & Co., Ltd. Price 6d.

The new issue of this useful handbook has as usual been revised and enlarged; the tables of logarithms have been reset in larger and much clearer type, and additions have been made to the tables of properties of steam, electrical data, &c.—the electrical section having been increased by 11 pages, and containing a great deal of practical information in small compass. There is an obvious slip in the statement of the laws of resistance on p. 192, and it should be mentioned that the specific resistance is given in terms of inch units. There appears to be an error in the lower right-hand figure on p. 189, one of the long sectors having no visible connection with the circuits, and on the next page credit is given to a compound-wound motor for large torque at starting, combined with constant speed; if the winding is such that the series assists the shunt, the speed will be less constant than that of a plain shunt motor, though the starting torque will be increased.

The section on alternators is behind the times, as magnet systems consisting of "two rings as is the usual method" are practically obsolete; moreover, the difference in phase between two-phase currents is *not* half a period, but a quarter, and two-phase currents in quadrature cannot be produced by the method suggested. The diagram of two-phase current waves on p. 212 is correct, but that of three-phase currents is utterly wrong; the middle wave ought to be inverted.

The statement on p. 213 that "the two-phase and polyphase motors have become formidable rivals" is rather misleading, as the idea intended to be conveyed is not that they rival each other, but that they rival synchronous motors; and polyphase motors are not necessarily asynchronous.

The table on p. 216, which purports to give the relative weights of copper for different systems, is spoilt by the lack of a statement of the conditions fulfilled in each case. As a matter of fact, these seem to be as follows:—A fixed pressure of supply, with given efficiency of transmission, as, for example, in the supply to glow lamps of a certain voltage. Naturally, under these conditions the comparison shows un-

expected results—for example, two-phase with three wires comes out better than two-phase with four wires, and three-phase with four wires requires only two-fifths the copper for three-phase with three wires! But this comparison is worse than worthless when high-pressure feeders are in question.

Electric welding forms a new section, and is well treated, though "Benardos" is as usual mis-spelt Bernardos, and Voltex appears as Volten. A section on testing has also been added, but needs revision, as it is in places difficult (without foreknowledge) to gather whether the ohmmeter test is applicable to conductor or insulation resistance. The concluding section on the care of dynamos and motors is excellent.

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

25,175. "Improvements in and relating to pendant, electrolier, and bracket switch connections." J. F. SMITH. November 17th.

25,182. "Improvements in trolley heads for electric railways and tramways." S. HUTCHINS and C. E FRY. November 17th.

25,195. "Improvements in electrical apparatus suitable for the ignition of gases and inflammable vapours, and for other purposes." A. ECKSTEIN and H. J. COATES. November 17th.

25,197. "Improved means for operating electric switches, taps, valves, and the like." L. SCHÜLER. November 17th.

25,216. "Improvements in electrical cut-outs and regulators, and their applications." H. LEITNER and R. N. LUCAS. November 17th.

25,232. "Improvements in fire alarm posts." A. C. BROWN. November 17th.

25,240. "Improvements in electrical instrument for signalling on railways." E. TYER, F. T. HOLLINS and F. W. LEAKE. November 17th.

25,263. "Improvements in and relating to electrical fuses." H. W. COX. November 18th.

25,278. "An electric tramcar or like trolley pulley guide." W. MOOREHEAD and A. TAYLOR, JUN. November 18th.

25,287. "Improvements in telephone systems." WAYNE, C. WRIGHT and J. W. PIERSON. November 18th. (Complete.)

25,288. "An improved electric current indicator." A. DENNY, J. A. ROBERTSON and C. H. JOHNSON. November 18th. (Complete.)

25,327. "Improvements in systems of regulating alternating-current electric motors." THE BRITISH THOMSON-HOUSTON CO., LTD., D. P. THOMSON and B. C. CLINKER. November 18th.

25,330. "Improvements in systems of electrical distribution." J. S. PECK. (Date applied for under Patents Act, 1901, March 21st, 1902, being date of application in United States.) November 18th. (Complete.)

25,342. "Improvements in trolley poles." T. C. BUDER. November 18th. (Complete.)

25,353. "Improved arrangement of the mercury cathode in voltameters, without diaphragms, for the decomposition of alkaline chlorides." A. CORRADO. November 18th. (Complete.)

25,354. "Improvements in the electrolytic treatment of liquids of all kinds." A. CORRADO. November 18th.

25,368. "The electric arm and trolley wheel controller." T. WILSON. November 18th.

25,371. "Apparatus for working portable fire engines, pumps, and the like, by means of an electrical current." W. R. B. LOCKIE. (R. Lefebvre and the firm of La Société A. Thirion et Fils, France.) November 18th.

25,377. "Improvements in arc lamps for electric lighting." J. W. BOWLEY and A. WALTERS. November 19.h.

25 437. "Improvements in or connected with electric signalling lamps for naval and other purposes." A. GRAHAM. (M. Casabona, Italy.) November 19th.

25,435. "Improvements in and relating to electric telegraphy." P. O'NEIL. November 19th.

25,436. "Improvements in and relating to interrupters for induction coils and the like." F. L. MUIRHEAD and J. PARE. November 19th.

25,441. "Improvements in electricity meters." C. W. G. LITTLE. November 19th. (Complete.)

25,442. "Improvements in secondary electrodes for electrolytic apparatus, more especially intended for use in the manufacture of chlorates." F. IMHOFF and THE UNITED ALKALI CO., LTD. November 19th.

25,444. "Improvements in clocks and electrical winding devices therefor." H. COHEN. November 19th.

25,482. "Improved rotary reversing gear for electric motors, dynamos and the like." W. ELLERTON. November 20th.

25,500. "Improvements in electric incandescent lamps." G. HOOKHAM. November 20th.

25,511. "Improvements in carbon or brush holders for dynamo-electric machines and the like." C. ZABEL, B. ZABEL and W. ZABEL. November 20th. (Complete.)

25,519. "Improved telephonic apparatus." D. CORSI. November 20th.

25,522. "Improvements in boosters for charging and discharging storage batteries; and regulating the pressure of the bus-bars." CROMPTON & Co., LTD., and J. R. MACINTOSH. November 20th.

25,524. "Improvements in arc lamps and electrodes therefor." LA SOCIÉTÉ G. ET P. DE MESTRAL. (Date applied for under Patents Act, 1901, February 28th, 1902, being date of application in France.) November 20th. (Complete.)

25,545. "Improvements in or relating to incandescent electric lamps." G. E. BATTYE. November 20th.

25,554. "Improvements in and relating to electric contacts." C. DE KANDO. November 20th. (Complete.)

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25,570. "Improvements in tower wagons for trimming arc lamps or for repairing the conductors of the overhead system of electric traction." S. RAWLINSON, W. RAWLINSON and J. RAWLINSON. November 21st.

25,576. "Improvements in electric current meters." H. V. KRAMER & Co., E. H. HORSTMANN and A. HORSTMANN. November 21st.

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25,738. "Improvements in or additions to insulators for telegraph, telephone and electric light cables or conductors." E. J. CHAMBERS. November 22nd.

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